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TRANSFORMER CONNECTIONS.
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ELECTRIC PUMPING AND IRRIGATION.
BY B. A. ETCHEVERRY.

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HYDROELECTRIC DEVELOPMENT ON KLAMATH RIVER

BY J. C. BOYLE.

View of Gorge and Proposed Dam in Outline.

The hydroelectric development now under construction for the California-Oregon Power Company, is situated on the Klamath River thirteen miles east of the Southern Pacific Railroad station at Thrall, Cal. It is near the geographical center of a territory of 10,000 square miles in Southern Oregon and Northern California over which the company is now distributing 20,000 horsepower and in which it will eventually develop 150,000 horsepower. The nearness of the installation to the central distributing station of the company makes it a valuable economical power acquisition.

The engineering structures, dam, power house and forebay, with all the smaller structures are combined under the name of Klamath River Dam No. 1. They are located together practically as a unit at the head of a canyon which has been formed by the Klamath River, eroding five distinct lava flows. Although the country surrounding the construction site is principally lava, and the walls of the canyon

themselves vary to 250 ft. in height in lava, the river in its erosion has exposed a reef across the canyon at the location of the dam, approximately 130 ft. high. This reef is of andesite, apparently continuous for considerable distance on both sides of the canyon and considered the oldest exposed formation in the country.

Geographical conditions upstream from the site indicate that at one time the river ran over this reef, 130 ft. above its present bed. During the time that the river was at this height the water was backed up approximately 5 miles and formed a natural lake which varied in width to a mile at the widest part.

It is now proposed to fill the gorge made by the river in eroding the reef, with a concrete dam, and cover the old original lake bottom with a new artificial lake. The new lake will have a surface area

Map of Territory Served by California-Oregon Power Company.

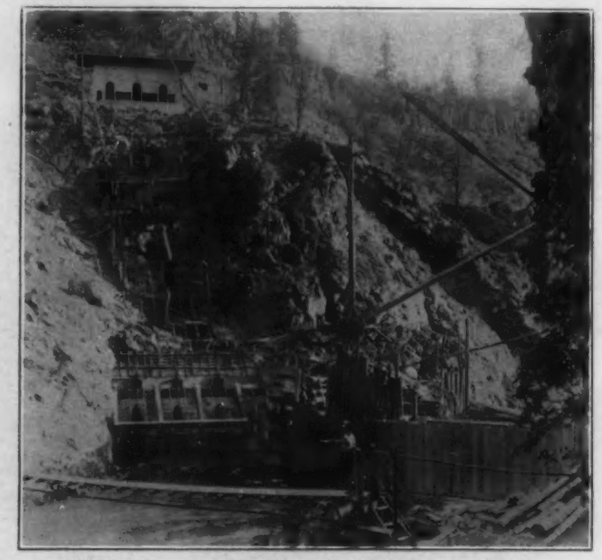
of 1000 acres and will have a catchment of 77,000 acre ft. This will be the third lake on the course of the Klamath River between its source and the construction site. Two large Klamath Lakes at present regulate the flow of the river at its source so that the high water mark at the construction site is never over 6 ft. above the low water mark, and the new lake with its regulation will control the floods of the river to a still greater degree. From gaugings taken for one and one-half years near the site, the maximum discharge of the river has been 4500 cu. ft. per second, and the minimum discharge has been 1450 cu. ft. per second. Taking the average for the same period as 2000 cu. ft. per second and allowing it to flow into the lake, it will take 20 days for the lake to fill. For utilizing a portion of this body of water allowance is being made for lowering the lake level 2 ft., thus supplying 2000 acre ft, of storage water to be used with the flow of the river for power during the low water season or to be used whenever a demand is made for it.

Construction Features.

Two of the most interesting construction features of this installation are, the diversion of the river from its channel while the foundations are being placed for the dam, and the procuring and delivering of material for the installation.

Diversion.

The width of the canyon at the base of the dam is 70 ft., all of which is taken up by the water of the river. For 150 ft. above the dam and for 350 ft. below the dam, the river channel has a grade of 2 ft. per hundred, producing a velocity in the water of about 20 ft. per second. The erosion produced by such a current would not permit winging the river from side to side, neither would blasting in the river bottom permit fluming the river, so a wing dam of



Side Hill Construction Already Accomplished.

rock-filled cribs, 30 ft. high was made 100 ft. upstream from the main dam.

This wing dam diverts the river from its original channel through an unlined tunnel around the east end of the dam. This tunnel is 356 ft. long with a cross section of 16 ft. by 18 ft. and a grade of 2 ft. per hundred.

On entering the tunnel the water passes through three sets of headgates, designed for 110 ft. pressure head and designed large enough to carry the average flow of the river under a head of 10 ft. Each set of gates consists of a clack valve covering the entrance to a 6 ft. depth by 30 ft. pipe, with a butterfly valve 6 ft. in diameter in the middle of the pipe and a 12 in. by-pass valve to the chamber between the large valves for equalizing the pressure behind the clack valve. Each valve is operated directly and independently by a specially designed operating wheel on an operating platform above the crest of the dam. The three pipes containing the three sets of valves are placed side by side horizontally in the direction

of the tunnel and securely concreted together, thus forming a solid block to the entrance of the tunnel.

Delivery System.

In the delivering of materials, supplies and equipment to the site, a valuable acquisition has been made of a standard gauge branch railroad which extends up the Klamath River from Thrall. By building a spur track less than a mile in length to connect with this railroad, all the freight can be delivered directly from Thrall (13 miles) to the edge of the bluff overlooking the dam site. The construction camp, warehouses, machine shop, cement house, etc., are all located at the end of this railroad spur.

The top of the bluff overlooking the dam site is 100 ft. in elevation higher than the crest of the dam. The first 50 ft. of this elevation is taken up by a mixing plant, consisting of two sand machines, two rock breakers, and two mixers, all electrically operated. The output of this plant will be 720 cu. yds. of concrete per day of 9 hours.

Back from the edge of the bluff 400 ft. is a cinder cone of a consistent quality of black volcanic cinder, which, after analyses and extensive tests was found to be useful as a substitute for sand in the concrete. A gravity tramway to the edge of the bluff at the mixing plant, will handle the cinder directly to the two sand machines, which together will crush it to the required size and deposit it in a storage bin below.

The two rock breakers in the mixing plant will crush rock handled directly to them by the derrick from the quarry, and discharge the broken pieces into a storage bin beneath them.

All the cement used will be handled from the cars to the storage house or directly from the cars to the mixing plant and after passing a small storage bin will be measured into the charging hoppers of the mixers.

The ingredients thus passing into the mixers by gravity are mixed at the rate of 40 cu. ft. per batch into concrete. The concrete is discharged from the spouts of the mixers into open troughs in which it travels by gravity across the canyon or to any spot where it is to be placed. Remixers, boiling boxes and branch troughs can be placed where needed.

For delivering the rock to be laid with the concrete, a rock cableway with a traveling carrier has been provided. The rock will be quarried from a lava bluff down stream from the forebay but above it in elevation. That which goes into the dam as laid stone will be taken by gravity to the forebay level to be handled with the carrier to any place in the dam and the small rock quarried at the same time will be taken by the derrick directly from the quarry to the rock breakers above.

The economical value of such a gravity system can best be underestimated when the fact is considered that by means of it, all the concrete for the forebay, all the concrete for the power house and three-quarters of the concrete in the main dam can be placed, some 55,000 yds. in all, without elevating a yard of it.

The head gates, wing dam, mixing plant and smaller engineering structures have been completed, and in all probabilities concreting on the larger structures, dam, power house and forebay, will be started in the early summer of 1913. Upon completion of this installation the California-Oregon Power Company will have added to its power developments a hydroelectric plant capable of producing 53,000 horsepower. This along with the available storage for peak loads, within one and one-half miles of the central switching station at Fall Creek, will make it one of the controlling plants of the company's extensive distributing system.

The Dam.

The dam to be built will be of the arch-gravity type, 130 ft. in height above the bed of the river, 90 ft. thick at the base and 13 ft. thick at the top. The length of the crest will be 400 ft., curved on the arc of a circle of 356 ft. radius, curvature upstream. The center 200 ft. of the crest will be an overflow section capable of discharging the highest flood waters. At the upper toe there will be a cutoff wall 10 ft. thick extending below the foundation of the dam at least 10 ft., and at the lower toe there will be provided an apron which will discharge the overflow water in a horizontal position.

Owing to the position of the canyon walls at the dam site, it was found impossible to place the structure perpendicular to the river bed, the west abutment being further down stream than the east abutment. However, by making the dam curved with a 356 ft. radius the ends were found to strike the canyon walls nearly perpendicularly.

The total yardage of the dam will be about 35,000, of which between 40 and 50 per cent will be laid stone. To reinforce the dam on the bottom and on the upstream side, and to facilitate in handling forms, 30 lb. railroad rails will be imbedded in the concrete. These will be spaced 4 ft. centers, 4 ft. from the face of the concrete and laced together horizontally both across the dam and through the dam.

The Power House.

The power house will be of reinforced concrete with floor dimensions 70 ft. by 170 ft. and will eventually contain four complete hydroelectric units with exciters, switchboards and transformers.

Each unit will be made up of a 12,500 k.v.a., 10,000 kw. at 80 per cent power factor, 200 r.p.m., 2300 volts, generator, weighing 325,470 lb., connected with an 18,600 h.p. cylindrical type hydraulic turbine of 84 per cent efficiency, 20 per cent speed rise, 200 r.p.m., weighing 400,000 lb. and governed by an a.c. oil pressure type, fly ball governor of 75,000 ft. pounds capacity.

The penstocks for each unit will be a pipe 125 ft. long, 17 ft. in diameter, and on a hill slope of 37° 30′ from the power house. The penstock will be made of sheet steel ½ in. thick at the upper end and ¾ in. thick where it enters the turbine. The water carried in it will have a velocity of about 5 ft. per second, depending on the load on the turbine.

The discharge from the turbine will be through a draught tube of special curved design located beneath the turbine and the generator floor. It will be made of concrete heavily reinforced on the top with I-beams. The area of the draught tube increases from 103.8 sq. ft. at the bottom of the turbine to 535 sq. ft. where the water leaves the power house.

The exciter units will consist of two trubine driven exciters and one motor generator exciter. The turbine driven exciters will be 200 kw., 720 r.p.m., 250 volts, and the turbine will be 300 h.p., 720 r.p.m., 83 per cent efficiency and connected with an oil pressure type, fly ball governor of 10,000 ft. pounds capacity. These units will be so connected that any one can be used on any four main generators.

For each unit in the power house there will be 3 single-phase transformers each of 4165 k.v.a., 2300 volts. The current from the generators will be run through a gallery switchboard to these transformers, thence out on a short line of one and one-half miles to the central switching and transforming station at Fall Creek.

The Forebay.

The forebay will be the supply reservoir for the penstocks for the power house. It is located at the west end of and adjoining the main dam and extends 200 ft. around the canyon to a position directly above the power house. Excavation has been made to a depth of 25 ft. below the ultimate crest of the dam, allowing 6000 cu. ft. per second to enter to the penstocks at a velocity of 5 ft. per second. An auxiliary spillway has been provided on the side of the forebay adjoining the dam, for relief when the water in the forebay rises above normal, and for taking care of any surge in the penstocks. A set of three gates will be provided for each penstock. These gates will be operated independently in sets so that any unit can be closed down without effecting the others. Racks and screens will be provided independent of the gates of sufficient size to allow the passage of the water and to take out all floating material.

The outer wall of the forebay, where the penstocks enter will be 10 ft. thick, 30 ft. high and anchored at the bottom. The inner wall will be a reservoir wall of 6 in. thickness with a batter of 1 in 10 and made continuous with the floor system. Both inner wall and floor system will be reinforced as a floor slab. Ample floor drains and side drains will be provided to take care of any seepage through the concrete.

The work is under the supervision of Mr. Sidney Sprout, superintending engineer of the California-Oregon Power Company, and Mr. A. C. Sprout, construction engineer of the California-Oregon Power Company, J. C. Boyle being engineer in charge.

TRAVELING AN ELECTRIC-HAULAGE ROAD.

In a discussion of accidents from mine cars and locomotives, the Bureau of Mines in its circular No. 11, thus describes dangers in traveling on an electric-haulage road:

The road you have to take in going to your working place is likely to be an electric-haulage road, because in the level mines of the United States, except in some gaseous mines, electric haulage is being used much more than any other mechanical means of hauling cars.

If you are carrying tools, such as a pick, a bar, or a drill, do not carry them over your shoulder. Many fatal accidents have happened because tools so carried struck the trolley wire. Even if the power is off the wire when you pass, get in the habit of not touching it.

TRANSFORMER CONNECTIONS.

BY W. A. HILLEBRAND AND E. R. SHEPARD.

(Concluded.)

Three transformers may be used with excellent results, on balanced or unbalanced loads, but only when the transformers used as the top of the T, a b of Fig. 15, are in multiple on the two-phase side. The

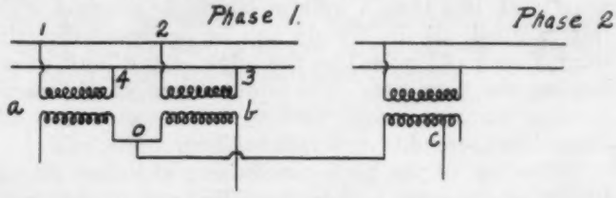


Fig. 15.

current in o c, which must divide at o and flow oppositely to a and b, induces in the circuit 1-2-3-4 a circulating current which prevents any choking effect.

An attempt to operate with coils 1-4 and 2-3 in series, as in Fig. 16, will lead to extreme unbalancing,

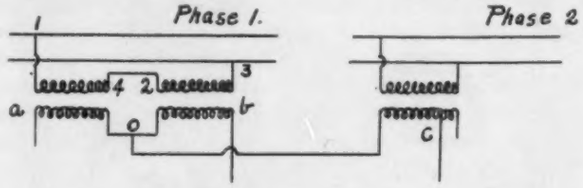


Fig. 16.

for currents cannot now flow in the circuit 1-4-2-3 to neutralize the choking effect of the currents flowing oppositely from o to a and to b.

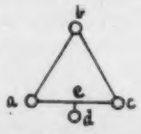


Fig. 17

In Fig. 17 is shown a system for furnishing both two and three-phase service at a common voltage, using for the most part the same transformers and but four wires. The three-phase system is a, b, c; the two-phase ac and bd.

To obtain the two-phase system from the three-phase, all that is necessary is to add the voltage d e, equal to 13.4 per cent of the delta voltage a b, and of the phase position be. Practically this may be accomplished by any of the connections shown in Figs. 18 to 21 inclusive.

In the connection of Fig. 18, b d is an auto transformer or primary of a standard transformer, connected at e, an 86.6 per cent tap. Instead, a transformer may be employed having the ratios 2200:440:

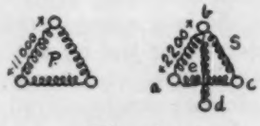


Fig. 18

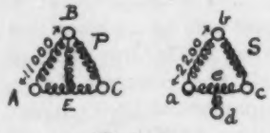


Fig. 19

220:110, in which case the full primary is used across b e and three-fourths of the secondary as e d. The rating of b d need only be 13.4 per cent of that of

either of the others.

Fig. 19 requires for b e the full primary of an 11,000 volt transformer, and the secondary e d, three-fourths of a nominal 440 volt winding. The capacity of this transformer is also but 13.4 per cent of that of either of the others.

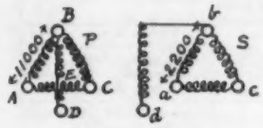


Fig. 20

Fig. 21

B D of Fig. 20 is an 11,000:2200 volt transformer of the same capacity as each of the others.

In Fig. 21 B D has an odd ratio of 11,000:395 or 37.3:1, whence it is not to be considered as a practical case.

Technically, the behavior of all of these cases is similar so that only the connection of Fig. 18, reproduced in Fig. 22, will be considered in analyzing the flow of currents in the transformers.

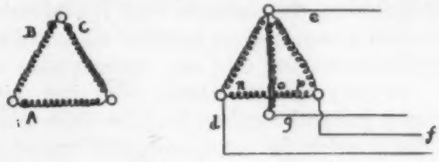


Fig 22

Single-phase current drawn by e g is supplied by transformers e d and e f and flows in opposite directions through n o and p o. With non-inductive load this current is 30 degrees out of phase with e d and

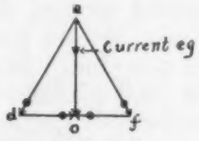


Fig. 23

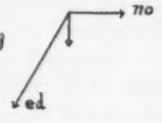


Fig. 24

Fig. 25

e f and 90 degrees out of phase with n o and p o. The vector diagrams are shown in Fig. 23 to 25 inclusive.

Single-phase current drawn by d f is principally furnished by transformer n o p but also in part by the parallel circuit d e f. On non-inductive load the current furnished by transformer n o p is in phase with voltage d f, whereas that furnished by circuit d e f is 60 degrees out of phase with e.m.f.'s d e and e f. The The vector diagram is given in Fig. 26 and 27.

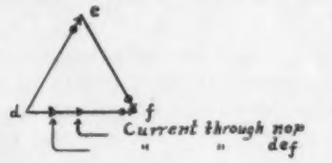


Fig. 26.

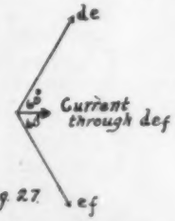


Fig. 27

Any three-phase current supplied to a balanced load, flows equally in each of the delta connected transformers at the power factor of the load.

The two-phase load draws currents, some of which flow through the transformers at power factors other than that of the load. When these currents of various power factor combine with currents drawn by a three-phase load, the resultants in the different transformers or in the two secondary coils of transformer n o p will not be alike.

As an illustrative case, the vector diagrams for a balanced two-phase load of 12 amperes per terminal at unity power factor and a balanced three-phase load of 12 amperes per terminal at 86.6 per cent power factor lagging, are shown in Figs. 28 to 31 inclusive, for the four circuits d e, e f, n o, o p, of Fig. 22. The further assumption is made that of the 12 amperes two-phase load drawn by d f, 8 amperes flow through n o p and 4 amperes via d e f.

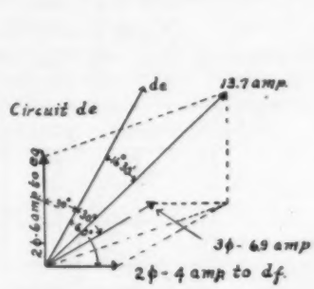


Fig. 28.

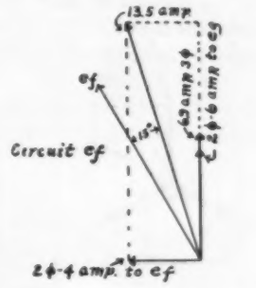


Fig. 29

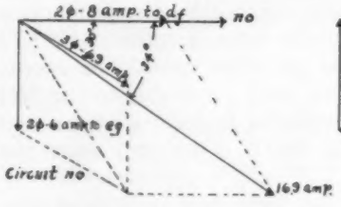


Fig. 30

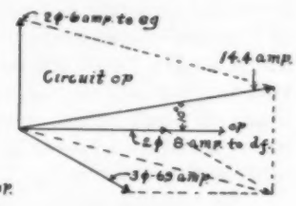


Fig. 31.

These diagrams represent currents in the secondaries, neglecting magnetizing and load current in current o e, the primary of the auto transformer. The primary current in transformer n o p is half the vector sum of currents in n o and o p, reducing to basis 1:1 transformation.

In an actual case the current distribution is altered by the fact that due to the different currents and power factors, the various sections will regulate differently, causing the ultimate distribution to depart from the simple law of Figs. 28 to 31, in a way that may be difficult to calculate. However, the following record of an actual test may serve to indicate what might be expected. Where two and three-phase loads were both applied, each was of the same value as when applied singly. The letter designations refer to Fig. 22 and primary currents are expressed in secondary terms.

Transformers e f, f d and e g are 7½ kw. 2200-220-110 volt, shell type, of the same make and period. Transformer e d is a 4 kw. core type transformer of same voltage rating but of an earlier period and different manufacture.

It would appear that with balanced two and three phase load, that transformer which is n o p of Fig. 22 carries somewhat the greater current. Any unbal-

ancing of the two-phase load tends to overload this same transformer which carries the currents of both phases. When the power factors of the two and three-phase loads are equal, the total currents in each half of the secondary of n o p are equal.

If

I_3 = amperes per terminal 3-phase.

I_2 = amperes per terminal 2-phase.

an approximation to the maximum possible secondary current in either half of this transformer is

$$I = .57\, I_3 + .84\, I_2.$$

Two-phase and three-phase service may also be furnished over four wires by means of the connection shown in Fig. 32, which requires however the use

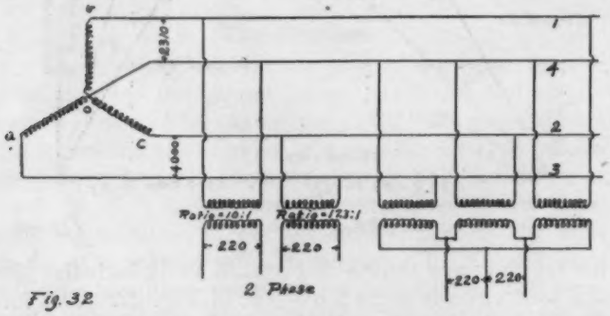


Fig. 32

of a transformer with an odd ratio, 17.3:1, for each two-phase motor installation. Half of the two-phase power is furnished by transformer o b and half by the other two transformers, so that, in the proportion of the two-phase load to the total, o b should be 1.73 times as great as each of the other two. The excess volt-ampere capacity of a o and o c is due to the fact that the single phase current is furnished by o a and o c at a reduced power factor, 86.6 per cent when the load is non-inductive.

An unusual scheme for deriving a two-phase supply from a three-phase source, using three transformers, is illustrated in Fig. 33, in which o e is a separate

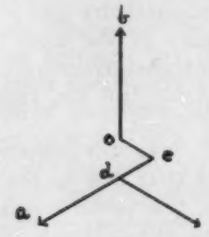


Fig. 33

coil wound on the same core as d c. The two-phase voltages are b d and a c. Three-phase cannot be supplied. Referred to o b, voltages o e and e d may be derived as follows:

$$* \quad bd = ob + od = ac. \qquad (1.)$$

Calling $oe = ed = x$.

Then $ob + 2x \sin 30° = 2\,(ob - x) \cos 30°$.

$$x = .267\ ob.$$

From equation 1, $ob + .267\ (ob) = ac$.

$$ac = 1.267\ ob.$$

That is, the new two-phase voltage is 26.7 per cent greater than the three-phase neutral or 73 per cent of the original three-phase delta electromotive force.

The primaries of the system must be connected in delta. The three transformers are of the same volt ampere rating but this connection reduces the power output when fully loaded to 84.4 per cent of the aggregate capacity as single-phase apparatus.

No	CURRENTS									VOLTAGES				LOAD
	A	B	C	d	e	f	g	n	p	de	ef	fg	eg	
1					15					light = 115 loaded = 114				Single-phase, non-inductive on eg. Transformer ed open circuited.
2					15.1					light = 119 loaded = 117				Same as No 1. Transformer ef open circuited.
3	3	11.6	8.0		15.3			11.5	7.3	120.5	121.5	120.5	118.0	Same as No 1. All transformers in service
4	10.6	13.6	9.0	15.4	15.4	15.4	15.4	14.3	12.8	123	122	122	120	Balanced, non-inductive 2 phase.
5	9.8	12.6	10.0	15.5	15.0	14.5	0	9.0	9.1	121	120	120	119	3 phase induction motor.
6	19	23.2	18	31	31	29	15.2	22.8	18.9	119	120	118	118	Combined loads of 4+5.
7	11	12.8	9.8	15	14.2	15	14.2	14.4	13.1	119	118	119	116	2-phase induction motor.
8	13.2	21.6	18	29.5	29	31	15.0	21.6	21.6	118	117	116	116	Two and three phase motors of 5 and 7

Relationship of Currents, Voltages and Loads in Varying Circuits.

In conclusion, the authors wish it understood that they have not attempted to analyze all known or possible combinations for two and three-phase transformation, but only typical cases, with the purpose of presenting a general method for the determination of current distribution in interconnected transformers.

PULLING ELECTRIC CABLE IN PANAMA CANAL LOCKS.

Electric cables for the control, power, and lighting systems of the locks will be carried in vitrified clay duct, which has already been placed at Gatun and Pedro Miguel Locks and is being placed at Miraflores. For the control and power systems 246 miles of lead covered cable are to be pulled through these ducts, 40 per cent of the total amount that was placed by the largest power company in the United States during the twenty years preceding 1908. In addition there are 112 miles of wire of miscellaneous sizes from No. 12 up to 00 B. & S. gage for the lighting system.

This work in the locks was begun in October and will be finished in June. On account of the large amount of cable to be handled the expedient of laying it from an electrically driven winch has been resorted to. Before the operation is begun the ducts are carefully cleaned. Then a lead wire is pulled through, and by this means a manila cable is drawn through the duct. The electric cable is attached to the rope, and the winch is set in motion. By this method it is possible to pull 900 ft. lengths of No. 0000 B. & S. gage lead covered cable at one time, whereas the average length by other methods is about 300 ft. The outside diameter of this cable is a trifle more than 2 in. In such a length the cable passes through two intermediate manholes, and is greased at three points to aid in reducing friction. The advantage of pulling the long sections at one operation is that the making of two joints is saved, and this is a considerable economy. The winch used for the purpose is mounted upon trucks operated over the return tracks of the towing system. The cable is being placed directly below the floor of the operating tunnel, and therefore the pull by the winch is direct.

ELECTRICAL PUMPING AND IRRIGATION

DESIGN OF REGULATOR AT HEAD OF MAIN CANAL

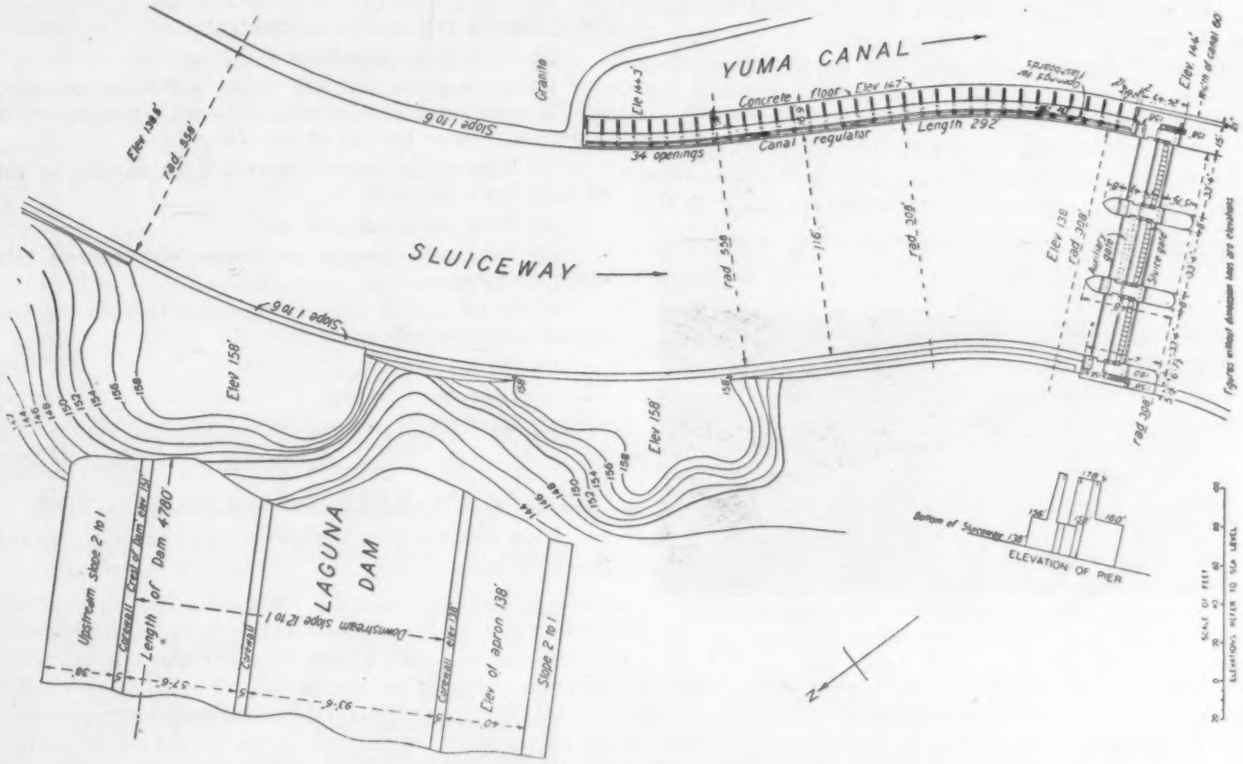
BY B. A. ETCHEVERRY.

The factors entering in the design of regulators are:

1st. Position of regulator relative to weir.
2d. Relative elevation of sill of headgates and crest of weir.
3d. Height and width of gate openings.
4th. Elevation of top of headgates and operating floor.
5th. Details and design of headgates.

1st. Position of regulator.

The most desirable position for the regulator is at one end of the weir, directly above it and at right angles to the axis of the weir. The adjacent scouring sluices keep a clear channel in front of the headgates. The general plan of the diversion dam and headworks for the North Platte project shows the arrangement of the different parts of the diversion works on a typical irrigation system. Where the river carries considerable sand or silt the regulator may be formed by placing at the head of the canal an overflow wall, at right angles to the weir, parallel and adjacent to the sluiceway, and locating the headgates proper lower down, either on the same axis as the weir, or at some distance below. The overfall wall and the headgates with the channel in between form a basin; the water passes over the wall into the basin, and the flow into the canal is regulated by the headgates. The object of the overflow wall is to skim only the surface water, and to accomplish this it is necessary to use a length of crest which will give the required volume of water in the canal, for the desired depth of water on the crest. This depth of water will usually represent the required difference in elevation between the weir crest and the crest of the wall. This form of construction is illustrated by the diversion works on the Shoshone River for the Corbett tunnel (see preceding article in Journal of Electricity, Power and Gas, Feb. 15, 1913). The same result may be obtained by regulating the flow over the overfall wall by means of gates placed above and at the crest of the wall. This will obviate the necessity for the headgates below, and the only difference between this form and the one first mentioned is that a larger total width of gateway must be used. This will increase the cost of gates which, however, will be at least partly offset by the omission of the separate overfall wall and basin. This form of construction is well illustrated by the headworks of the Yuma project. The headworks consist of a diversion weir of the Indian type with a large sluiceway and canal headgate on each end of the weir, one on the California side and the other on the Arizona side. The sluiceway and regulator at the head of the canal on the Arizona side is shown in the accompanying plan. The sluiceway, which is 116 feet wide, runs around the end of the weir. The flow through this sluiceway is controlled by three large gates. The uphill bank of the sluiceway for a length of 292 ft. upstream from the sluicegates is the canal regulator. It consists of an overflow wall divided into 34 openings by piers between which flashboards can be in-



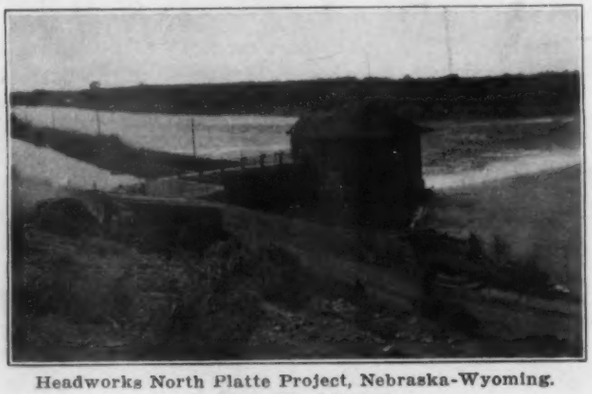
Canal Regulator, Laguna Dam, California-Arizona.

serted to raise or lower the crest of the wall so as to skim the surface of the water and regulate the flow into the canal. A similar arrangement of sluiceway and regulator is shown by the diversion works of the Salt River Project at the site of the Granite Reef Dam.

2d. Relative elevation of sill of headgates and crest of weir.

The diversion dam must always be built high enough to insure a full depth of water in the canal. This requires that the crest of the weir or the minimum low water level over the weir be made slightly higher than the full supply level of water in the canal, depending on the velocity desired through the gate openings. The desired velocity need not exceed the velocity in the canal. It is preferable to use a greater area of gate openings and a lower height of weir. Usually less than 6 in. difference in elevation between the full supply level in the canal and the crest of the weir or the low water level over the weir is sufficient. On most streams the depth of overflow during the period of low stream flow is small and often nothing.

A common case in practice is where the diversion weir must be built at a selected weir site to raise the water to a desired water level in the canal at the



Headworks North Platte Project, Nebraska-Wyoming. Project, Washington.

headgate. This condition determines the elevation of the weir crest. Other cases which occur in practice are those where the weir site is selected but where the available fall in the diversion line permits considerable range in the selection of the water level in the canal. For these conditions it is necessary to find the combination which will give the most economic total cost of diversion weir, headgates and canal. A low water level in the canal will decrease the height of weir, but may increase the depth of cut of the diversion canal; this is usually the case where the bank of the river on which the canal has to be constructed is a flat bench.

3d. Height and width of gate openings.

The total cross section of gate openings is determined by the velocity of flow through the gates. This, as previously stated, need not be greater than the velocity in the canals. A low velocity increases the total area of gate opening but decreases the required weir height. A large height of gate opening decreases the required total width of gates, but may require a higher weir. The maximum height of openings will not exceed the depth of water in the canal and usually will be less. A smaller height requires that the gate sill be raised above the floor of the canal. This decreases the required weir height and also the intensity of pressure on the gates and it has the advantage that the top water of the stream is taken in the canal; this is desirable for streams carrying much sand or silt. The total width of gateway is usually divided by piers, buttresses or columns into a number of openings, whose maximum width depends somewhat on the pressure and type of gate, but is rarely greater than 8 ft. and is usually from 4 to 6 ft.

4th. Elevation of top of headgate and operating platform.

The top of the headgate and operating platform must be at least as high as the maximum high water level to prevent overtopping.

5th. Details and design of headgates.

The headgate structure consists of:

(a) An overflow wall and basin above the headgate, used in some cases when the water carries much silt and it is desired to skim the top of the water.

(b) Substructure consisting of a floor, aprons, or cut off walls and a gate sill.

(c) Wing walls and side walls.

(d) Buttresses, columns or frames with grooves into which the gates are set.

(e) Panel wall to close the openings between the buttresses above the gate openings.

(f) Gates.

(g) Operating platform.

(h) Gate lifting device.

THE K.V.A. RATING OF A GENERATOR.

In a three-phase alternating current circuit, the power is computed by the well-known formula

$$P = \frac{\sqrt{3}}{1000} EI \cos \theta$$

where

P = power in kilowatts.

E = voltage between wires.

I = current in amperes passing through one wire.

θ = the phase displacement between current and electromotive force.

$\cos \theta$ = power factor.

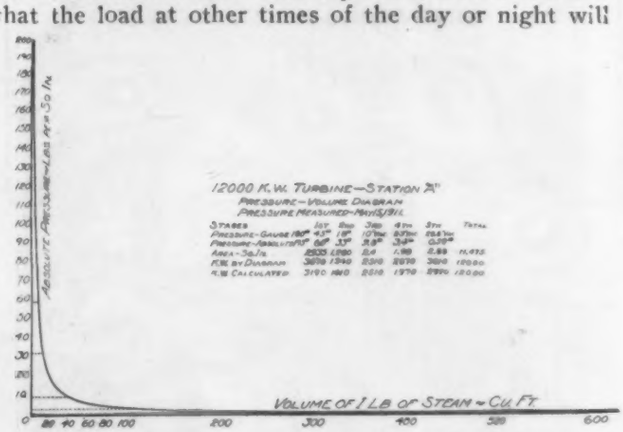
Since the characteristics of the external circuit thus impose a burden upon a generator to produce more voltage and more current when a highly inductive circuit is fed, the product of volts and amperes will thus be materially greater. Since the limit of the generating capacity of an alternator is dependent upon its ability to dissipate heat and since this generating for heat is caused both by strength of voltage and current attained in the generator windings, the output on kilowatt basis is thus lessened by the characteristics of the distributing network. Hence the only fair basis of rating a generator is on the kilovolt ampere product, which is at present almost universally adopted among manufacturers.

ELEMENTS OF STEAM POWER PLANT DESIGN

STEAM TURBINES AND BOILERS. II.

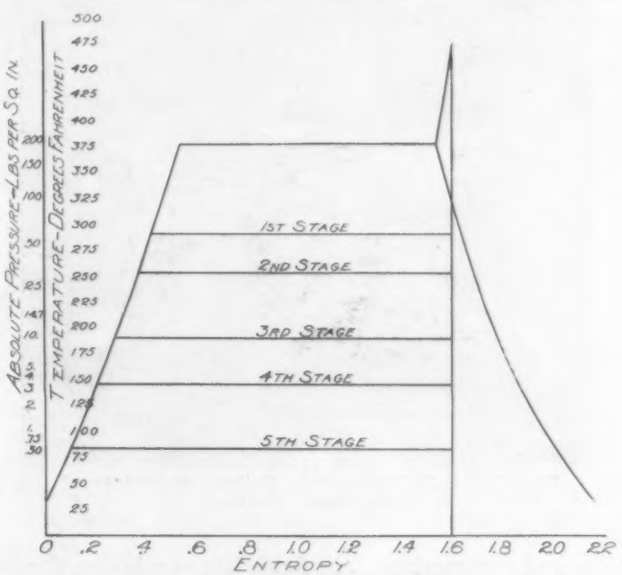
BY C. H. DELANEY.

In designing a steam power plant the first thing to be determined is the capacity to be installed. This is determined by the business conditions in the locality in which the plant is to be built; the amount of power used in the vicinity; and the amount of assistance required by the transmission system at times of low water, etc. Having determined on the total capacity of the power plant, the next thing to determine is the number of units to be installed and the size of each. Suppose for instance, it has been decided to build a plant having a maximum capacity of 12,000 kw. and suppose further, it is expected that the maximum of 12,000 kw. will be reached only during the peak of the load in the evening, and that there will be an industrial load in the day time, of 7000 kw. and that the load at other times of the day or night will



Pressure Volume Diagram for 12,000 kw. Turbine.

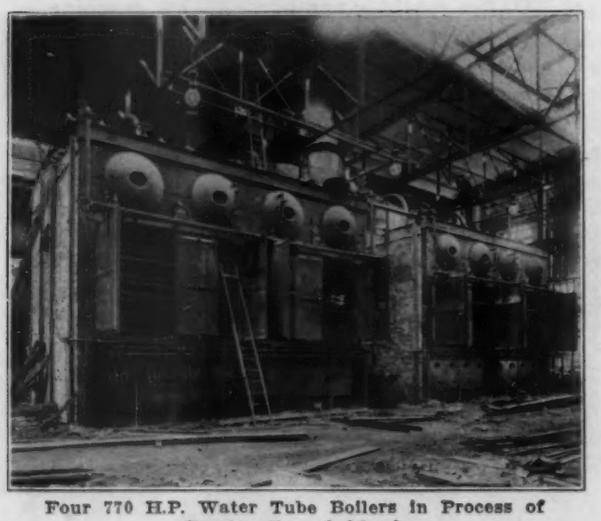
average about 2000 kw. To suit these conditions we might install a single unit having a capacity of 12,000 kw. or we might install two units, one of 7000 kw. and one of 5000 kw., or again we might install three units, one of 7000, one of 3000 and one of 2000 kw. In order to decide which is the best of these three combinations, it is necessary to consider the load curve of the machines. By this I mean a diagram giving the economy or water rate of the turbine at various loads. If the load curve has a sharp peak giving a good economy for a very small range in the capacity, it is best to install a number of machines of small capacity, rather than one large machine, as we are then able to operate each machine at a capacity suitable to its most efficient load at all times of the day. In the case of steam turbines, however, where the load curve is fairly flat, which means that the machine operates at good economy over a wide range in capacity, it is not worth while going to the expense and complication of installing three or four small machines instead of one large unit. There are serious objections, however, to a large plant having only one prime mover, as this machine must run as long as there is any load whatever to be carried, and if anything goes wrong with it, the plant is thrown completely out of business. If there are two machines of smaller capacity and one of them is to be shut down for repairs, it is still possible to carry half of the load on the other one, and by making the repairs during the hours of light load, they may be carried on without interfering with the operation of the plant to the smallest extent. The cost of the different sizes of machines and of their installation must of course be very carefully considered, but it is probable in the case suggested above, that it would be decided that the best combination to suit the conditions would be to install one 7000 kw. machine and one 5000 kw. machine.



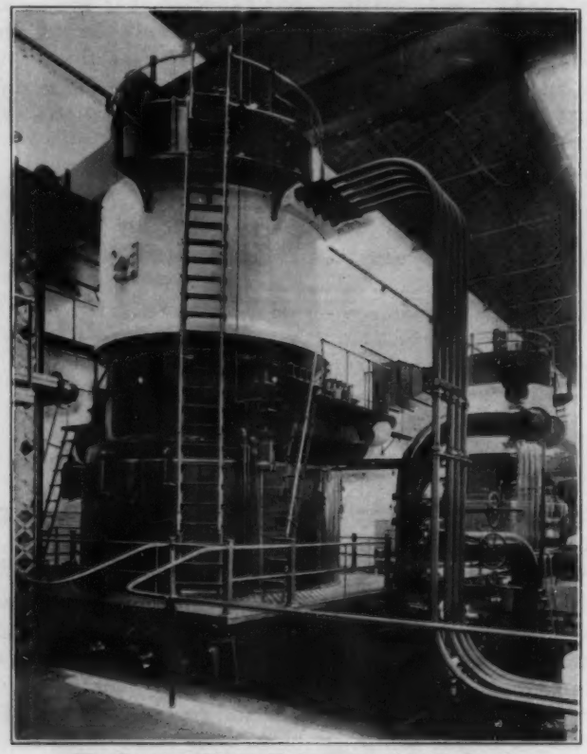
Temperature Entropy Diagram for 12,000 kw. Turbine.

The type of turbine selected will depend to some extent on the size, as certain types are best suited for large sizes and other types are best suited for small sizes. There are certain theoretical problems involved in the design of turbines which have been solved by different manufacturers in different ways. In some types the high pressure steam expands direct in the buckets of the wheels. In others the steam expands first in nozzles designed to convert its pressure energy into velocity energy, so that when it reaches the buckets it has a considerably lower pressure but a much higher velocity than in the first case. Various combinations of these two general types are used by different manufacturers. In determining which is the best machine to install, however, it is not so much the general principles involved that must be considered as the design of the details, such as the methods of fastening the buckets to the wheels, the clearance between the movable and fixed parts, the facility for making repairs and the provision for expansion and contraction due to heat. These are the points that determine the reliability of the machine in operation, and this is the most important consideration in power plant work; for, while high efficiency is something much to be desired, the machine that can be depended upon to carry the load through a critical time is the best machine to install.

Having determined on the size and type of steam turbine to be installed, the next thing to be considered is the boiler capacity required. Boilers are of two general types—water tube and fire tube—but owing to the greater reliability and safety of water tube boilers and the much smaller space they occupy, they are the only ones considered nowadays in large power plants. There are a great many different makes of water tube boilers on the market, all of which produce good dry steam when fired at their ordinary rating. There is a great tendency at the present time, however, toward forcing boilers to very high capacities, which, when combined with intermittent firing results in severe strains in the boiler due to expansion and contraction. The flexibility of a boiler, therefore, which enables it to stand this severe service without excessive strain is the first thing to look for in picking out the make of boiler to be installed. The ease with which the boiler can be cleaned and repaired is also of prime importance. The economy of a boiler depends more on its operation than its design, but it is important to have sufficient furnace volume, suitable area for the gas passages with proper baffling, and a stack of proper dimensions to give the correct draft. The furnace arrangement must be such as to insure perfect combustion of the fuel before the gases strike the heating surface of the boiler, for once the gases are cooled there is no further chance of their burning. Boilers are usually rated on the basis of 10 sq. ft. of heating surface per h.p., one h.p. being taken at 34½ lb. of water evaporated per hour from and at 212 degrees. According to this rating each sq. ft. of heating surface in the boiler will evaporate 3½ lb. of water per hour. While this is the most economical point at which boilers can be operated, it is nevertheless true that a boiler can be forced to evaporate twice this amount or 7 lb. per sq. ft. of heating surface, and inasmuch as the full load of 12,000 kw. is expected for only a few hours each day, it would be more economical to force the boilers hard during the few hours than to fire up a number of additional boilers for the peak load and shut them down again two or three hours later. While 7 lb. evaporation per sq. ft. is too much to figure on in every day operation, it is safe to base the amount of boiler heating surface on an evaporation of say, 5½ lb. per sq. ft. of heating surface at the maximum load. Assuming that the total steam required for the turbine and all the auxiliaries will not exceed 18 lb. per kw.-hr., it would be necessary therefore to install $12{,}000 \times 18 \div 5\frac{1}{2} = 39{,}400$ sq. ft. of heating surface or 3940 boiler h.p. It is necessary, however, to provide sufficient boiler capacity to allow one boiler to be shut down for cleaning purposes. We may, therefore, have 7-650 h.p. boilers of 6-800 h.p. boilers, in either of which combinations we could have over 3900 h.p. in operation and one boiler cut out for cleaning. In this connection it may be stated that the larger the boiler the less it will cost per horsepower to install and the more economical it will be in operation. With boilers that are too large, however, too much additional capacity would have to be installed to allow for cleaning and it is therefore advisable to have not less than six units. Great success has been obtained in Detroit with boilers rated at 2300 h.p. which can be overloaded to such an extent that almost 4000 h.p. may be obtained from a single unit. In the plant referred to, however, there will eventually be installed ten of these boilers, so that each one is only one-tenth the capacity of the entire plant. Two of these boilers would be sufficient to operate the plant we are considering, but if a tube in one of them should blow out, one-half the capacity of the plant would be lost.



Four 770 H.P. Water Tube Boilers in Process of Construction, Oakland.



The Largest Steam Unit on the Pacific Coast.
15,000 Kw. Vertical Steam Turbine, Installed at the Potrero, San Francisco.

TREATMENT FOR ELECTRIC SHOCK.

The National Electric Light Association has compiled the above information through a committee of distinguished experts as follows:

Dr. W. B. Cannon, Chairman, Professor of Physiology, Harvard University; Dr. George W. Crile, Professor of Surgery, Western Reserve University; Dr. Yandell Henderson, Professor of Physiology, Yale University; Dr. S. J. Meltzer, Head of Department of Physiology and Pharmacology, Rockefeller Institute for Medical Research; Dr. Edw. Anthony Spitzka, Director and Professor of General Anatomy; Daniel Baugh Institute of Anatomy, Jefferson Medical College; Mr. W. C. Eglin, Past-President, National Electric Light Association; Dr. A. E. Kennelly, Professor of Electrical Engineering, Harvard University; Dr. Elihu Thomson, Electrician, General Electric Company; Mr. W. D. Weaver, Secretary, Editor, Electrical World.

Fig. 1. Inspiration; Pressure Off.

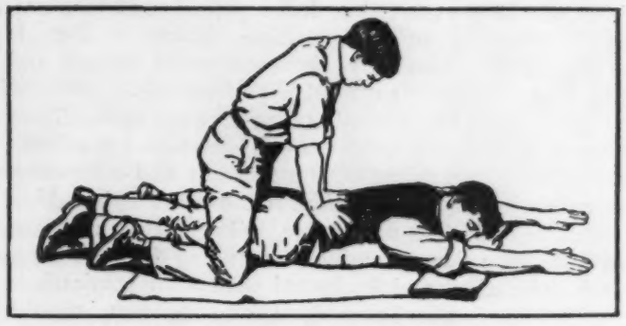


Fig. 2. Expiration; Pressure On.

An accidental electric shock usually does not kill at once, but may only stun the victim and for a while stop his breathing.

The shock is not likely to be immediately fatal, because:

(a) The conductors may make only a brief and imperfect contact with the body.

(b) The skin, unless it is wet, offers high resistance to the current.

Hope of restoring the victim lies in prompt and continued use of artificial respiration. The reasons for this statement are:

(a) The body continuously depends on an exchange of air, as shown by the fact that we must breathe in and out about fifteen times a minute.

(b) If the body is not thus repeatedly supplied with air, suffocation occurs.

(c) Persons whose breathing has been stopped by electric shock have been reported restored after artificial respiration has been continued for approximately two hours.

The Schafer, or "prone pressure" method of artificial respiration, slightly modified, is illustrated and described in the following resuscitation rules. The advantages of this method are:

(a) Easy performance; little muscular exertion is required.

(b) Larger ventilation of the lungs than by the supine method.

(c) Simplicity; the operator makes no complex motions and readily learns the method on first trial.

(d) No trouble from the tongue falling back into the air passage.

(e) No risk of injury to the liver or ribs if the method is executed with proper care.

Aid can be rendered best by one who has studied the rules and has learned them by practice on a volunteer subject.

Instructions for Resuscitation.

Follow these instructions even if victim appears dead.

I.—Break the Circuit Immediately.

1. With a single quick motion separate the victim from the live conductor. In so doing avoid receiving a shock yourself. Many have, by their carelessness, received injury in trying to disconnect victims of shock from live conductors.

Observe the following precautions:

(a) Use a dry coat, a dry rope, a dry stick or board, or any other dry non-conductor to move either the victim or the wire, so as to break the electrical contact. Beware of using metal or any moist material. The victim's loose clothing, if dry, may be used to pull him away; do not touch the soles or heels of his shoes while he remains in contact—the nails are dangerous.

(b) If the body must be touched by your hands, be sure to cover them with rubber gloves, mackintosh, rubber sheeting or dry cloth; or stand on a dry board or on some other dry insulating surface. If possible, use only one hand.

If the victim is conducting the current to ground, and is convulsively clutching the live conductor, it may be easier to shut off the current by lifting him than by leaving him on the ground and trying to break his grasp.

2. Open the nearest switch, if that is the quickest way to break the circuit.

3. If necessary to cut a live wire, use an ax or a hatchet with a dry wooden handle, or properly insulated pliers.

II.—Send for the Nearest Doctor.

This should be done without a moment's delay, as soon as the accident occurs, and while the victim is being removed from the conductor.

III.—Attend Instantly to Victim's Breathing.

(1) As soon as the victim is clear of the live conductor, quickly feel with your finger in his mouth and throat and remove any foreign body (tobacco, false teeth, etc.). Then begin artificial respiration at once. Do not stop to loosen the patient's clothing; every moment of delay is serious.

(2) Lay the subject on his belly, with arms extended as straight forward as possible, and with face

to one side, so that the nose and mouth are free for breathing (see Fig. 1). Let an assistant draw forward the subject's tongue.

(3) Kneel straddling the subject's thighs and facing his head; put the palms of your hands on the loins (on the muscles of the small of the back), with thumbs nearly touching each other, and with fingers spread over the lowest ribs (see Fig. 1).

(4) With arms held straight, swing forward slowly so that the weight of your body is gradually brought to bear upon the subject (see Fig. 2). This operation, which should take from two to three seconds, must not be violent—internal organs may be injured. The lower part of the chest and also the abdomen are thus compressed, and air is forced out of the lungs.

(5) Now immediately swing backward so as to remove the pressure, but leave your hands in place, thus returning to the position shown in Fig. 1. Through their elasticity, the chest walls expand and the lungs are thus supplied with fresh air.

(6) After two seconds swing forward again. Thus repeat deliberately twelve to fifteen times a minute the double movement of compression and release—a complete respiration in four or five seconds. If a watch or a clock is not visible, follow the natural rate of your own deep breathing—swinging forward with each expiration, and backward with each inspiration.

While this is being done, an assistant should loosen any tight clothing about the subject's neck, chest, or waist.

(7) Continue artificial respiration (if necessary, two hours or longer), without interruption, until natural breathing is restored, or until a physician arrives. Even after natural breathing begins, carefully watch that it continues. If it stops, start artificial respiration again.

During the period of operation, keep the subject warm by applying a proper covering and by laying beside his body bottles or rubber bags filled with warm (not hot) water. The attention to keeping the subject warm should be given by an assistant or assistants.

(8) Do not give any liquids whatever by mouth until the subject is fully conscious.

First Care of Burns.

When natural respiration has been restored, burns, if serious, should be attended to until a doctor arrives,

A raw or blistered surface should be protected from the air. If clothing sticks, do not peel it off—cut around it. The adherent cloth, or a dressing of cotton of other soft material applied to the burned surface, should be saturated with picric acid (0.5 per cent). If this is not at hand, use a solution of baking soda (one teaspoonful to a pint of water), or the wound may be coated with a paste of flour and water. Or it may be protected with a heavy oil, such as machine oil, transformer oil, vaseline, linseed, carron or olive oil. Cover the dressing with cotton, gauze, lint, clean waste, clean handkerchiefs, or other soft cloth, held lightly in place by a bandage.

The same coverings should be lightly bandaged over a dry, charred burn, but without wetting the burned region or applying oil to it.

Do not open blisters.

DISCUSSION ON ARTIFICIAL TRANSMISSION LINES.[1]

Clarence S. Hull: I would like to know how on these artificial lines you will duplicate the switching and the charging conditions on 100,000 volt real line? It would be interesting to know how that is done, so that you can take your oscillograms and see what happens when you charge your arresters or throw in and out the line either with high or low tension switches.

H. F. Fisher: That is one of the problems which has not been fully determined in the testing of artificial transmission lines; how you would exactly duplicate some of these conditions. The speed at which you rupture the circuit is determined by experiment and can be readily duplicated in the artificial line. The charging of lightning arresters is a problem that I doubt very much if we can investigate at all on the artificial line. It would seem as though the main difficulty in the past has been the taking care of the large energy flow to which the arrester is subjected when first connected to the transmission system and would thus appear to be a problem in lightning arrester design. The actual line disturbance can be duplicated artificially.

A. J. Bowie Jr.: I would like to ask Mr. Fisher if the tests on artificial lines have developed any results which would not be normally anticipated with reference to transmission lines; whether any particular new facts were brought out, or just confirmation of the old results?

H. F. Fisher: Tests have been too recent in date to fully prophecy possibilities for determining new phenomena. The tests on the lumpy lines show nothing new at all. They simply confirm what we already knew and are suitable only for conditions of steady or permanent energy flow. But there are possibilities, I believe, in the testing of artificial lines for traveling waves, impulses and those things which have not been studied in detail in the past.

Mr. Fries: The question of leakage conductance has been referred to. I would like to find out whether any attempt has been made to introduce leakage conductance into these transmission lines. It seems to me, as far as resistance, inductance and distributed capacity are concerned our theory has been so well verified not only in actual lines but in artificial lines already built that we are really able to foretell very clearly what is going to happen so far as these constants are concerned; but what we are looking to the physical laboratories for more information about is the leakage conductance and the corona. Those are the things that today are most important, because they are not subject to such rigid mathematical calculation as the other phenomena are. Of course, I understand that the effect of corona could not be duplicated today on any artificial transmission line, but it seems to me that the leakage conductance might be taken care of. That is at present the most fruitful field of application for artificial lines; otherwise, they seem to be more of pedagogic interest than useful to the practical engineer; because even transient phenomena can now be so closely followed by mathematical investigation (although it is a rather laborious work) that we really don't need the testing. I would like to know if there was any attempt made to duplicate the leakage conductance? If so, with what results?

H. F. Fisher: As far as I know, there have been no attempts made to accurately duplicate the leakage conductance. You would have a certain control over that by the choice of material and number of condenser sheets, but as far as I know, it has never been attempted to duplicate it with any great degree of accuracy.

Mr. Fries: Corona appears first at a certain critical voltage; consequently these artificial lines, operated at low voltage, don't give us any information about corona. Reading for instance the paper by Dr. Kennelly and Mr. Lieberknecht, I find their results so closely with theory that it seems

[1]The main paper on this subject, by H. F. Fisher, appeared in the Journal of Electricity, Power and Gas, January 11, 1912.

to me nothing further is to be learned from artificial lines except as regards the influence of leakage conductance; but here we would indeed be grateful for numerical results.

A. J. Bowie Jr.: With reference to the opening of switches under load, the number of oscillations required to extinguish the arc is not a matter of any material importance, unless the presence of these oscillations is accompanied with voltage oscillations of undesirable effect. In other words, the fact that the switch will gradually open the circuit is an advantage rather than a disadvantage. It is the cushioning effect that one gets with a properly designed switch, which is a positive advantage in breaking the circuit. The switch shown here—the Townsend Air Break switch—is evidently a switch which was capable of handling the load; so the results obtained therewith cannot be used as an indication of what a switch properly designed would accomplish.

There seems to be no voltage distortion whatever, even with the current distortion which followed; in other words, a very small per cent of voltage distortion accompanied the operation of the switch, even though it did not break the load.

J. P. Jollyman: In considering the question of artificial lines and the question of actual lines and the connected apparatus, we must not forget that the line is only a part of the transmission system; and certain of the characteristics of other parts of the system are very important and have an important bearing on the action of the system as a whole. For instance, in a general way in a long distance transmission system, composed of generators, step-up transformers, line and step-down transformers, the line would have some such constants as a resistance loss from six to ten per cent and an actual drop of twenty to thirty per cent; the transformers, step up and step down, would have a total reactance of not less than eight per cent, so they form a rather important factor in the regulation of the system. The resistance loss in the transformers will be small, perhaps a little less than one per cent, taking them as a whole and at full load. The generators form a very important link in the system and one which is very difficult to control. The reactance in an ordinary water wheel generator is perhaps forty per cent; I have seen some machines with fifty per cent reactance. When it is realized that the same current applies not only to the line but to the generators and transformers, and the power factor may be very far from unity, you can readily see that we have to pay close attention to the effect of the other pieces of apparatus in the system as well as that of the line itself; and I should suggest that in the experimental work which might be done with artificial lines, it might be profitable to consider adding something to represent at least the transformers. The transformers are after all an essential part of the system. We may be able to control the generators in such a manner that we may be assured of a constant 'bus voltage; but there are transformers at each end of the line and you cannot get away from them if the transmission voltage is high.

From a brief consideration of the relative characteristics of the different parts of the system it may be seen that not only is the line important, but in planning a system as a whole, or predicting its performance, you must take careful account not only of the line but the transformers particularly and the generators as well.

Thereupon an adjournment was taken.

A PARTIAL LIST OF VOLTAGES IN CALIFORNIA HYDRO-ELECTRIC PRACTICE.

BY F. J. MASLIN.

Name.	Lgth.	K.V.	Remarks.
American River			Bought by Western States. Sac., Stockton, Placerville.
California & Oregon.			
Coast Co.'s Elect. Co.	97	33	Contemplates raising to 60. Will have some 100 at San Jose.
Edison Elect. Co....			Changed to So. Cal. Edison.
Gt. West. Power Co.	158	100	
Holton Power Co....	33		On aqueduct leading to Imperial Valley.
Humboldt G. & E...	65	30	Bought by Western States Electric.
La Grange P. Co..			Changed to Yosemite P. Co.
Los Ang. Aqueduct..	270	100	Plant projected on Owens River.
	166	33	
Mt. Whitney P. Co..		34	Raised from 17. Contemplate 60.
Monterey Co. G. & E.	18	33	Have new lines projected.
Nevada-California ...	100	55	Operates near Bishop, Polta, Tonopah, Goldfield, Rhyolite,
Nor. Calif. P. Co....	258	22	Old Sac. Valley P. Co.
	196	60	Bought by Nor. Cal. P. Co.
Total	454	..	Nor. Calif. P. Co.
Ontario Power Co. ..			Bought by Pac. Lt. & P. Co..
Oro Lt. & P. Co....	12	30	Oro. Lt. & P. Co.
Pacific Lt. & P. Co...			
Pacific Power Co.....			A subsidiary Co. of the Nevada-Calif. P. Co. Not generally known. Plant on Londy Lake; 1500 kw. to Rawhide.
P. G. & E.....	330	60	Distance between most remote points.
	140	60	Distance DeSabla-Oakland.
	1175	60	Total miles of lines 60 kv.
Sac. Valley P. Co...	258	22	Now Nor. Calif. P. Co.
San Joaquin L. & P..		60	
San Joaquin L. & P..		30	Proposed.
Sierra & S. F.....	138	104-94	Bought up Knight's Ferry plant of Stanislaus Consolidated and the Tuolumne Co. W. & El. Pr. Co.
Siskiyou El. P. Co...	169	60	Yreka to Dunsmuir.
Snow Mt. W. & P. Co.	115	60	Ukiah to Napa. Sells to P. G. & E.
So. Cal. Edison.....	122	75	Kern River to L. A.
So. Cal. Edison.....	75	33	Approx. Dist. Santa Ana, Mill Creek and Lytle plants from L. A.
So. Cal. Edison.....	200	..	Dist. bet. most remote points.
So. Cal. Edison.....	450	..	Approx. total mileage. May be low.
So. Sierra P. Co.....	237		Buys wholesale from Nev.-Calif. P Co.
Truckee River G. E..	135	60-30(2) 60-33(1)	
Tuolumne W. & E..			See Sierra & S. F.
Utica Gold Min. Co.			Near Angels.
Ventura Co. P. Co...		55	
Western States El...	65	30	Operates line Eureka to Junction City. Bought out American River Elect.
Yosemite Power Co..			

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The click, the drop, bing—it's done!!

Treatment for Electric Shock

Such rapid succession of events catches the unwary wholly unprepared for the emergency. On another page of this issue appears the details of procedure in event of the unheralded apparently fatal electric shock. Too much publicity can not be given to such a matter as this. Long experience has clearly shown that the victim of the electric shock is often not killed outright, though from every outward appearance the body is lifeless. The imperfect contact between the body and the dangerous sources of potential, together with the high resistance offered by the skin of the human being, has saved many a victim from complete disaster, if properly treated by his comrades immediately after the horrifying scene.

Artificial respiration, even over a period lasting as long as two hours has been known by prompt and continued action, to safely bring a victim back to a life of usefulness.

Such being the case, it is clearly up to you, dear reader, to turn at once to page 183 of this issue, and, for all time to come, master the details for such an emergency.

The A. B. C. of Generator Output Ratings

The subject of ratings by various manufacturers still mystifies the layman and often appalls the engineer when he seeks a rational basis whereupon to check the guarantee in an official test. Thus, so long as the manufacturer insists upon guaranteeing a turbo-generator, for instance, under conditions of operation of pressure, vacuum and superheat that are to be reduced to standard conditions largely by rules of the thumb, so long will confidence be lost in the mind of the purchaser.

There are other conditions of rating, however, which are based upon scientific principles and yet often due to the hazy grasp of engineering fundamentals on the part of the purchaser, the true meaning of the rating is wholly misunderstood. The present rating of the output of a turbo-generator in terms of kilovolt-amperes instead of kilowatts presents such a condition of affairs. Thus, the kilo-volt-ampere output is determined by taking the product of the electrical pressure (measured in thousands of volts) and the amperes of current flowing through the terminal wire; while the kilowatt output, or actual power delivered, is this same product multiplied again by the so-called power factor of the electrical circuit.

Alternating currents and alternating voltages rise and fall many times a second somewhat similar to a child's swing, swaying back and forth with rhythmic beat. Consider for a minute two swings, in which one represents the swelling and dying away of the voltage in a wire and the other the swelling and dying away of the resulting current. If these two swings beat back and forth in unison they are said to be in phase. However, if the second swing encounters a seeming resistance in getting started although it will still beat back and forth in the same time as the other, yet it will always lag behind the former by a definite amount.

Again, with throttle wide open, one may easily, if he disregards the possibilities of arrest, travel forty to fifty miles an hour in an automobile on a properly

constructed level western boulevard. Traveling over the same road, equally well constructed and even with the same power of automobile engine, will nevertheless prove materially less thrilling when climbing a grade of eight to ten per cent. Thus, through no fault of the automobile engine design the speed due to external impedance encountered is materially reduced. Hence the speed of an automobile may well be rated on a level ground basis, and in exactly a similar manner the output of a generator is properly rated when considering the energy that may be pumped into an alternating current network containing no inductive effects.

Since alternating current networks as a rule seldom pulsate with voltage and current actually in phase, due to the inductive resistance of the circuit, such a thing as zero angle of displacement is somewhat of a fiction. From elementary trigonometry we learn that the cosine of zero angle is unity and since the cosine of this displacement angle is defined as the power factor it is evident that unity power factor rarely occurs.

The output limits of a generator depend more on its capacity to dissipate heat than on any other factor. Certain of these heat generating variables depend upon the current involved, while others such as hysterisis losses vary as a function of the voltage. It is clearly evident, then, that a generator should not be penalized because it must pump energy into a network having less than unity power factor. Hence, since 80 per cent represents fairly average power factors, it has been found more representative to rate the dynamo output on a kilo-volt-ampere basis.

Much Needed Water Right Legislation

Three features in water right legislation, hitherto unrecognized officially, although tried out informally in several Western states, may well be put upon the statutes. First, there should be a statute compelling the rotative use of water in irrigation where such procedure is necessary for the highest use; secondly, the exchange of water should be legalized; and in the third instance, the several states should exert themselves more forcefully by appropriating sufficient moneys to gather accurate and reliable data on the most promising power sites still undeveloped and within the confines of the commonwealth undertaking such investigation. A detailed discussion of these three proposals will prove of profit and interest to all well-wishers of Western enterprise.

It has been established in the irrigation art that what is known as 2/5ths of a miner's inch of water is amply sufficient, if properly applied, to irrigate an acre of arid land. Such a quantity of water legally defined in the majority of Western states amounts to about five gallons per minute. In the good old days when the farmer had at his disposal 160 acres of land this would give him some sixty miner's inches of water or about 800 gallons per minute. By those who have in person experienced the vicissitudes of modern irrigation on a warm dry day, the decision is unanimous that to attempt to use less water at one time, even though but one acre is to be irrigated, is to waste in dry conducting ditches the major portion of the application. In recent years intensified farming has justly taken its place in western development. A ten-acre tract and even less is found under highest scientific development to adequately support an entire family. Picture, if you will however, anyone endeavoring to irrigate a ten-acre tract with a head of water equal to 5 gallons per minute. Like the windage and friction losses of the dynamo on light load, by far the major portion of the valuable application is lost without power generation. In Southern California, even 1/10th of a miner's inch of water is found sufficient per acre, where the most improved methods are utilized. Hence it is clearly evident that where necessary for the common good, the irrigationist should be compelled to rotate his water right to his neighbors and in return receive his application compounded in sufficient proportions for the highest use with minimum water supply.

To legalize the exchange of water is to accomplish a similar result. Many of the early appropriations take waters of a stream upon the low lying lands tributary thereto. The higher bench lands, though unthought of at first, have in recent years proved more valuable agriculturally. To get water upon these higher lands often requires an exchange. Thus the newcomer may often convey, economically, water to the low lying lands from another source and by an exchange for these waters, he may bring the older right upon his higher bench without in any way interfering with the quality and quantity of supply of his older neighbor. Such exchanges for the common good should under proper restriction be legally recognized.

Again, definite authentic data on the possible water power developments is of such public concern that a commonwealth is indeed putting its funds to the highest use when its moneys are appropriated to gather such information. A cautious procedure looking to only those sites of well-known natural possibilities should at first be attempted. The cost of such an undertaking may with justice be levied against the site to be liquidated when developed. Thus an opportunity will be given, both to the public and to the capitalist, to be fully informed on the possibilities of the particular project. The legislatures of Oregon and Washington both have under consideration the appropriating of $50,000 each for a full investigation of The Dalles of the Columbia River. Congress will also be asked to contribute a similar amount. Here is said to be located some half million electrical horsepower, greater in total than the world-beating Keokuk project now under way on the Mississippi. A preliminary investigation of the state engineer of Oregon, as appeared in our last issue, shows, too, that the ultimate development charges per horsepower may be expected to run far less than the Mississippi installation. The fact that present demands for power are wholly inadequate to utilize such vast powers is no legitimate reason why such investigations should not be undertaken. The industries of the world yearn for the happy hunting grounds of the West. Only through greatest economy of power development can such industries live. Let the world at large once have definite authentic data on the abundance of cheap power development and the future of the West as a manufacturing and industrial center is assured.

PERSONALS

ITEMS FOR THIS DEPARTMENT ARE SOLICITED FROM ALL READERS

Geo. J. Henry Jr., consulting hydraulic engineer, is visiting the Pacific Northwest.

Arnold Pfau, hydraulic engineer with the Allis-Chalmers Company, is at San Francisco.

S. E. H. Smith, representative of the Sunbeam Lamp Company at Vancouver, B. C., is visiting California.

H. Pim, representative of the Canadian General Electric Company at Vancouver, B. C., is at San Francisco.

F. E. Lehman, stores manager for the Western Electric Company at Los Angeles, was at San Francisco during the past week.

Theo. F. Dredge, Pacific Coast representative of the Pittsburg Piping & Equipment Company, is making a two months' Eastern trip.

J. C. Boyle, engineer in charge of the California-Oregon Power Company's new power plant, on the Klamath River, was at San Francisco during the past week.

Ralph L. Phelps, Pacific Coast manager of the Safety Insulated Wire & Cable Company, recently returned to San Francisco from a visit to the Eastern factory.

E. K. Patton of Chicago, western manager of the Bryant Electric Company, is at Los Angeles and will attend the meeting of the electrical jobbers at Del Monte, Cal., February 27, 28.

Louis C. Kelsey, consulting engineer, Portland, has been engaged to design a municipal lighting plant for Albany, Oregon, which will include a steam electric generator and 600 cluster light posts.

H. V. Carter, president of the Pacific States Electric Company, returned to Seattle from San Francisco this week upon receipt of news that their new Seattle house had been damaged by acid and water from a fire in the same building.

H. E. Sanderson, Pacific Coast manager of the Bryant Electric Company, and **Miles Steel** of the Benjamin Electric Company, have been appointed Jovian statesmen at large by **Frank E. Watts**, Eleventh National Jupiter of the Jovian Order.

Ralph D. Mershon, president of the American Institute of Electrical Engineers, has returned to New York City, after spending some time investigating the proposed transmission line construction of the Oro Electric Corporation in California.

Charles S. Johan, commercial manager and assistant engineer of the Federal Light & Traction Company, is at Deming, N. M., to confer with **Frank Monser**, manager of the Deming Ice & Electric Company, regarding line extensions into adjacent agricultural districts.

Herbert H. Cudmore, president of the Brilliant Electric Company, has been selected as arbitrator in charge of the department of arbitration of the National Quality Lamp Division of the General Electric Company, with headquarters at 30 Church street, New York City.

E. B. Strong, president and general manager of this journal, has returned from the East, where he attended the meeting of the transportation committee for the N. E. L. A. meeting at Chicago in June of this year. He reports great interest in the proposed special train from the Pacific Coast. He also attended the convention of the electrical jobbers at Buffalo.

R. B. Elder, Pacific Coast representative for the Ideal Electric & Manufacturing Company and the Moloney Electric Company, has returned to San Francisco from Marshfield, Ore., with the contract for complete motor equipment for the Coos Bay Pulp & Paper Company, one of the interests of the C. A. Smith Lumber and Manufacturing Company. This order aggregates 1060 h.p. in 18 heavy duty type induction motors, the largest being 200 h.p.

Alfred Still, who lately resigned his position as chief electrical engineer to the Mines Department of the Algoma Steel Corporation of Sault-Ste.-Marie, Ontario, Canada, has taken up a position at Purdue University, La Fayette, Ind., where he is in charge of the courses in electrical design at the school of electrical engineering. Mr. Still is a member of both the British and American Institutes of Electrical Engineers. He has made a special study of hydroelectric developments and transmission line problems, and has only recently returned from the Pacific Coast and Colorado, where he visited many of the important power systems. He is well known to the readers of this journal by reason of the excellent articles he has contributed in the past.

W. W. Briggs has resigned as assistant general sales manager of the Westinghouse Electric & Manufacturing Company, in charge of Pacific Coast territory, to join the Great Western Power Company. His official title has not yet been determined but he will devote his ability to increasing the company's current consumption. Mr. Briggs is one of the best known men in the electrical business on the Pacific Coast and mutual congratulations are being exchanged with regard to his new affiliation. He began his electrical career in 1886 as shop boy in the arc lamp repair department of the California Electric Light Company. Later he joined the Electric Improvement Company. In 1893 he went to Idaho as electrician with a mining company. In 1896 he joined the sales force of the Fort Wayne Electric Company at San Francisco, leaving them to join the sales department of the Westinghouse Electric & Manufacturing Company in 1899, where his advancement was most rapid, culminating in his appointment to the position just resigned in July, 1911.

MEETING NOTICES.

ENGINEERING MEETING AT SPOKANE.

On February 19-21 a general engineering and scientific meeting was held at Spokane, Wash., by the members and associates of the several societies there represented, this being held in place of the Second Annual Northwest Mining Convention.

The meeting was called to order on Wednesday morning by J. C. Ralston, who stated the objects and purposes of the meeting as being to promote more active co-operation, better practice, a higher code of ethics and to encourage the individual to become identified with the engineering or scientific organization which will be most helpful to him. The delegates were welcomed to the city of Spokane by Mayor W. J. Hindley.

A most interesting and comprehensive program of papers was presented on various phases of civil, mechanical, electrical and mining engineering as well as chemistry, forestry and education.

San Francisco Jovian Club.

The San Francisco Jovian Club held an enthusiastic luncheon on February 18 at Tait's Cafe, with an attendance of 65 members. F. H. Woodward presided. The principal business transacted was the adoption of the revised constitution of the Electrical Development League as the constitution for the local Jovian club. This is in accordance with the plan to merge the two organizations. It was also agreed that a nominating committee be appointed to nominate a new set of officers for the "Electrical Development and Jovian League" as the organization will be hereafter known. Mr. Nightingale then entertained the members with a most mystifying exhibit of sleight of hand.

Portland Jovian Luncheon Club.

There were 42 members of the Jovian Electrical League present at the weekly luncheon at the Hazelwood Thursday, February 6th. H. V. Carter, president of the Pacific States Electric Company, spoke on co-operation. L. F. Harza, spoke about the nitrate industry of Norway and the possibility of its production in this country providing electric power could be obtained cheap enough to compete with the foreign product. Mr. Harza stated that the natural product of Chili would last about fifty years at the present rate of consumption, which is increasing about 10 per cent per year. Messrs. Geo. Boring, Burnett Goodwin and Mahoney were appointed as a committee to investigate new quarters for the weekly luncheons. Messrs. Geo. Barker, C. R. Dederick and A. V. Olsen were appointed as the financial committee of the Jovian Electrical League, to devise a scheme to raise the necessary money to take care of the expenses of the League.

The Jovian Luncheon Club held its last luncheon in its present quarters in the Haelwood Grill, on February 13, and from now on will meet at the new Hotel Oregon. Mr. G. L. Priest, was chairman of the day, the meeting being devoted to "General Business."

Oregon Technical Club.

At the meeting of the Oregon Technical Club on February 11, Mr. Joseph Jacoberger of the American Institute of Architects, acted as chairman. Mr. W. H. Crawford outlined the new policy of the club as follows: "That a chairman will be appointed for each month and that he will choose his successor for the succeeeding month. Commencing with February 25, 1913, the luncheon will be held at the Portland Commercial Club. It is the desire of the joint committee who are managing the club to be able to make out a schedule for a number of meetings in advance and they desire the chairman of each body represented to hand in suggestions to the joint committee. The meeting of the 18th will be under the direction of the Oregon Society of Engineers, and the meeting of the 25th under the direction of the A. I. E. E. In the future the meetings will be held promptly at 12:10 p.m. and brought to a conclusion if possible at 1:25 p. m."

The subject of the meeting was "Pertinent Legislation," being a discussion by D. L. Williams, architect, on the proposed amendment to the "Lien Law." The main point being that the new law will require material dealers to notify owners of material delivery to jobs. Under the present law this is not necessary, and owners are at the mercy of unprincipled contractors, architects, and material men. Mr. L. F. Danforth, secretary of the Builders' Exchange, also endorsed this new amendment. Mr. E. F. Lawrence, architect, spoke in favor of the law before the legislature known as the "Excess Condemnation Bill." He pointed out that this law was a success in London, Paris, and about ten states of the Union. The club will give its "House Warming" dinner to members and their guests Saturday evening, February 22, at 247½ Start street. This will be the formal opening of its club rooms to its members, who number about 400 men in all branches of the engineering and architectural professions. A splendid time is assured as a special program has been provided with a keen eye to fun making.

Seattle Section A. I. E. E.

The February meeting of the Seattle Section of the American Institute of Electrical Engineers was held February 18th, in the assembly room, Chamber of Commerce, eighth floor, Central Building. The meeting was devoted to consideration of railway matters with particular attention to railway motors and control equipment. A short paper was read by Mr. A. A. Miller of the Westinghouse Company, followed by an illustrated talk by K. A. Schaller. About fifty stereopticon slides were shown, illustrating recent types of railway equipment. J. D. Ross is chairman and M. T. Crawford, secretary.

Oregon Society of Engineers.

The Oregon Society of Engineers held annual meeting and banquet at the Commercial Club on Thursday evening, February 13. Ninety members and guests were present. In the absence of President Henny, his annual address was read. Vice-president Wm. S. Turner presided and at the close of dinner called out many good toasts from apt speakers; among the guests responding were Mr. Elgin Stoddard of San Francisco, who was strong on "Our Pacific Coast Spirit," and Jos. F. Kinder, president of the Progressive Business Men's Club, who ably championed "United Effort of Clubs."

Dinner was followed by executive session, which disclosed the election of officers as follows: President, Walter H. Graves; Vice-presidents (term expiring 1916) W. H. Crawford, (term expiring 1914) John H. Lewis; Secretary, O. E. Stanley; Treasurer, Henry Blood; Directors (term expiring 1915) D. C. Henny, J. R. Townsend, (term expiring 1916) F. A. Naramore, Douglas W. Taylor, H. L. Vorse; Nominating Committee, Fred A. Ballin, C. E. Condit, Robt. S. Edwards, Louis C. Kelsey, E. B. Newcomb, Frederick Powell, Lewis I. Thompson, Fred D. Weber. Three applicants were admitted to membership.

The society has shown a substantial growth and proved beyond all doubt that it is on a sound footing and is destined to take its place among the most progressive, and therefore the most useful, technical associations of America.

San Francisco Section A. I. E. E.

A meeting of the San Francisco Section of the American Institute of Electrical Engineers will be held in Native Sons' Hall, 430 Mason street, on Friday evening, February 28, at 8 o'clock. The meeting will be preceded by a $1.00 table d'hote dinner at Jules Cafe at 6:30 p. m. A paper on "Operation of Transmission Systems" will be presented by Lee Hagood of the General Electric Company.

This paper will deal with the question of controlling the wattless, or idle, current in transmission lines and large feeders, so as to obtain uniform voltages at the desired values. This can be accomplished by synchronous machines located at the distribution centers controlled automatically with voltage regulators. By arranging the voltages at the generating stations at values somewhat near those to be maintained at the distribution centers, the power factor is also maintained at somewhere near unity power factor over a range of load from about half the peak load to the full peak load. This will effect the maximum use of the available k.v.a. capacity of the generators, transformers and transmission lines involved, which offers considerable flexibility in loading the generator unit efficiently, and, since the voltage is maintained practically uniform over the transmission lines, the necessity of taps on the main transformers is obviated.

The first part of the paper will take up the problem of a system having a small amount of charging current but a large inductive load, and the second part will deal with a system having high voltage transmssion lines, in which the charging current is of considerable magnitude. It will be shown that the problem in the two cases is quite similar.

Some data will be given, obtained from tests made by the author on the system of the Utica Gas & Electric Company. This will be substantially a resume of the author's article published in the General Electric Review of last December. The analysis of the problem as set forth in this article will be extended, to cover systems having long transmission lines. A method of calculation will be shown for long transmission lines, where distributed capacity and inductance must be considered, by which the amount of wattless k.v.a. can be determined for different loads that must be supplied by the synchronous machinery in order to maintain constant voltage drops.

There will be about 35 lantern slides used to illustrate the points brought out in the paper.

THE ELECTRICAL CONTRACTORS' DEPARTMENT

STANDARD SPECIFICATIONS FOR WIRING BUILDINGS.

(Continued.)

A Specification, which with the accompanying drawings, describes the work to be performed and the materials to be used in the construction and installation of the electric light and power wiring for the ..... on ..... streets, to be constructed for ....., Portland, Oregon, from the drawings and under he supervision of

.....

Architects.

Instructions to Bidders.

(1) Bidders are required to make their own estimates of quantities upon which to base their proposals, and are expected to thoroughly familiarize themselves with the intent and meaning of these specifications, as well as with the accompanying drawings, and make their own estimates of the facilities and difficulties attending the execution of the work.

(2) It must be understood that no claims will be allowed against the owners on account of any discrepancy in such estimate so made by bidders.

(3) It is the intention of these specifications to provide a complete system of electric light and power wiring required for the building, and everything necessary to provide a continuous electrical circuit from the service outlets to the farthest lamp outlet is to be included even though not specifically mentioned therein.

(4) The contractor is to furnish all materials necessary to complete the wiring of the building as per the true intent of the plans and specifications whether all the items are fully described and shown or not, it being understood that the plans are not wholly complete and that in their development a reasonable latitude is to be allowed.

(5) This contractor shall read the entire specifications in order to properly figure on all items that may appear relative to the work.

(6) In case these specifications are in any part deficient or not clearly expressed, the parties making the bids shall apply to the architects in writing for the required information before submitting their bids.

(7) Any sub-bidders figuring on any one or more subdivisions of the work shall include the general conditions wherever applicable to his part of the work.

(8) The architects reserve the rights to reject any or all bids.

(9) Drawings and specifications are to be returned to the architects with the bids.

(10) Changes to the plans and specifications may be made by the owners or architects from time to time, as they desire, and they shall in no way effect the contract, but the additional charge for making such changes in the work shall be figured and agreed upon by the architects in writing, and the contractor shall make no changes nor deviations from the plans and specifications unless so authorized in writing.

(11) The contractor shall protect all portions of the building and work during construction and shall make good any injuries to same caused by his operations.

(12) The contractor shall remove all rubbish resulting from his operations.

Time.

(13) The electric lighting contractor will be required to install that part of his work that is to be concealed in the walls or between floors and ceilings, and other rough work, in conjunction with the other buildings trades, and at such times as the progress of the other building operation will admit and require, and to install the finished work at such time as the progress of the interior finish of the building will admit, and as directed by the architects the entire work to be finished by the time to be determined and stated in the contract.

Contract.

(14) The form of contract to be signed by the contractor will be the regular building contract form prepared and used by the architects.

Drawings.

(15) The general building set of plans, comprising the floor plans, elevations, sections and large scale shall constitute the drawings illustrating the work required by this specification.

(16) Most symbols shown on drawings are those adopted by the National Electrical Contractors' Association.

(17) After the contract is let the electric lighting contractor shall prepare and submit to the architects for approval a complete set of working plans showing the method of running all circuits, the location of all outlets, switches, cutouts, etc., together with sizes of all mains and branches. For this purpose the architect will furnish a set of blue prints on which these plans may be drawn with colored pencil.

Capacity of Conductors.

(18) All switches and conductors, including service mains, feeders and branch circuits, are to have a conductivity of not less than 98 per cent (Matthiessen Standard) and are to be of such size that, when carrying full connected load, the maximum drop in pressure from the point where the service enters the building to the farthest lamp or power outlet will not exceed 2 per cent for lighting 4 per cent for power, and in no case is the current density to exceed 800 amperes per square inch of cross section.

(19) All bidders must specify in their bids the sizes of the service mains, various feeders, branch circuits, switches, and cutouts that they propose to install.

Tests.

(20) After completion of the electrical work, the architect will cause such tests to be made of the electrical installation as may be considered necessary. If the results of these tests show that the work does not comply with the requirements of the specification the wiring contractor shall immediately make all changes necessary to put the work in proper condition and shall pay the expense of all subsequent tests or inspections required to determine whether or not the work is satisfactory.

Material and Workmanship.

(21) All electrical apparatus and material to be of the best grade of standard manufacture, and approved by the Board of Fire Underwriters.

(22) The bottoms of all switch and cutout cabinets are to be inclined downward and out at an angle of 44 degrees to prevent the storing of ignitable material in such cabinets.

(23) All methods employed to be thoroughly modern and up to date and in all ways satisfactory to the architects and the wiring contractor agrees to replace any part or parts showing defects in workmanship or material during the period of twelve (12) calendar months from the date of acceptance.

Inspection.

(24) The general and all sub-wiring contractors will be required to comply with all city and state requirements and those of the Portland Railway, Light & Power Company.

(25) All work shall be installed in strict accordance with the latest edition of the "National Electrical Code" as adopted by the National Board of Fire Underwriters, and a certificate of inspection is to be obtained and paid for by

the contractor and delivered to the architects before final payment shall be made.

Note—The numerical clauses under the next heading "System" are general and may be applied in any specification; the alphabetical clauses are special, and the party writing the specifications must make a selection of the one meeting his requirements.

System.

(26) The building is to be wired for lighting on the balanced three-wire system having 117 volts between neutral and outside legs; and for power on the:

(a) Two-wire direct current system having ..... volts between wires.

(b) Three-wire three-phase alternating current system having 234 volts between any two wires.

(27) The mode of wiring to be that known as:

(a) Concealed metal conduit work, as all wires are to be run in galvanized iron conduits, same to be concealed in walls and between floors and ceilings.

(b) Exposed metal conduit work, as all wires are to be run in metal conduits, same to be placed on exterior of ceilings and walls.

(c) Concealed knob and tube work, as all wires are to be run concealed in walk and between floors and ceilings and to be supported by knobs and tubes.

(d) Moulding work, as all wires are to be run in moulding fastened to the ceilings and walls.

(e) Exposed or open work, as all wires are to be exposed on ceilings and walls (where such construction will not be in violation of the National Electric Code) and supported by knobs and cleats. (Cleats being preferred).

Note—The following are a few examples of how the detail specifications may be written for various classes of buildings and for different modes of wiring, the examples being arranged according to the superiority of the class of work, the highest grade of work coming first.

(To be continued.)

CONTRACTORS' NOTES.

Cohn Bros. of Portland, Oregon, are constructing a six-story re-inforced concrete building on the northeast corner of Yamhill and Third streets. The electrical installation is being done by the McPage, McKenney & Company, electrical contrastors and engineers of Seattle, Washington.

Morgan, Fleidner & Boyce are constructing an eight-story reinforced concrete building on the east side of Washington street, near Seventh street, Portland, Oregon. It is built especially for physicians and dentists. To provide ample capacity to take care of the electrical equipment of the up-to-date physicians' and dentists' offices, each room will be equipped with a power circuit of 50 amperes, if necessary. The scheme adopted is to run the conduit large enough to accommodate conductors to supply this capacity if needed. The circuit wires of the power circuits will not be placed in at the time of the construction, but will be "pulled in" from time to time as the occasion demands, consequently the only extra expense incurred in the original contract is the difference in cost of ½ in. conduit and ¾ in. or 1 in. conduit and a small additional labor cost.

This idea should be adopted in all office buildings and a great deal of future trouble and expense would be avoided, also better service given to the tenants. The electrical work is being done by their own electricians.

The new Majestic Theater, in Portland, Oregon, is scheduled to open on February 24, 1913. This is a fire-proof structure throughout, and the electrical installation was installed by Meecham & Babcock of Seattle, Wash.

BOOK REVIEWS.

Essentials of Electricity. By W. H. Timbie. Size: 5 in. x 7 in.; 263 pages; 222 illustrations; cloth binding. Published by John Wiley & Sons of New York, and for sale at the Technical Book Shop, 106 Rialto Bldg., San Francisco. Price $1.25.

This book, one of the Wiley technical series, is in the nature of a textbook for wiremen and the electrical trades. The author, who is head of the department of applied science at Wentworth Institute, has developed his text from notes used in short trade courses for students who wish to advance themselves in one or another of the electrical trades. The book treats first of the elementary principles of electricity and then proceeds with various methods and combinations of electric wiring. Generators, motors and batteries reecive also a proportionate share of treatment. The chapter on locating and correcting trouble is especially useful. The theory and information are presented clearly and forcibly, unclouded by a mass of foreign matter. The book will be found especially useful to men in the electrical contracting business and allied electrical trades.

Electrical Machine Design. By Alexander Gray. Size: 5½ in. x 8½ in; 528 pages; 317 illustrations; cloth binding. Published by McGraw-Hill Book Company of New York, and for sale at the Technical Book Shop, 106 Rialto Bldg., San Francisco. Price $4.00.

This book on the design and specification of direct and alternating current machinery, representing the practice in vogue at McGill University, is compiled from a mass of material which the author found necessary to tabulate during several years of experience as a designer of electrical apparatus. The book is divided in logical sequence under four main headings: Direct current machinery, alternators and synchronous motors, polyphase induction motors, and transformers. The procedure in design and the special problems completely outlined and then solved in detail are especially helpful. A summary of symbols is contained in the rear of the book, which, together with a comprehensive index of twelve pages, makes the labor easy when using the book as a reference for knotty problems in design. The book is indeed a most useful one, both as a reference for the designer and for the student who desires to master the elements of the art in electrical machine design.

Water, Its Purification and Use in The Industries. By William Wallace Christie, consulting engineer. Size: 5 in. x 7½ in.; 219 pages; 79 illustrations; cloth binding. Published by D. Van Nostrand Company of New York, and for sale at the Technical Book Shop, 106 Rialto Bldg., San Francisco. Price $2.00.

This book treats of water and its purification for use in the industries. Water for drinking purposes is, however, touched upon in its pages. The author, who has previously published many technical articles dealing with the subject, especially a book on scale corrosion and foaming in boiler waters, speaks with the authority of experience. Various processes of water softening are discussed, including a dessertation on aeration, sterilization, ozone and ice. By a liberal employment of illustration, the author has made a feature of the mechanical devices utilized in the purification of water. Numerous authorities are quoted and analyses collected from widely varying sources add force to the arguments presented. Much of the material appeared as a series of articles in a recent widely known technical paper, consequently the theories have stood the test of recent discussion.

Steam Boilers. By E. M. Sheally. Size: 6½ in. x. 8½ in.; 356 pages; 185 illustrations; cloth binding. Published by the McGraw-Hill Book Company of New York, and for sale at the Technical Book Shop, 106 Rialto Bldg., San Francisco. Price $2.50.

The general subjects treated are types of boilers, boiler calculations and design, effects of heat and properties of steam, fuels and boiler accessories. Inspection and testing of boilers are also dealt with within its pages.

INDUSTRIAL

GAS-ELECTRIC MOTOR CARS ON CHICAGO, MILWAUKEE & PUGET SOUND RAILWAY.

The Chicago, Milwaukee & Puget Sound Railway Company has recently placed in service two General Electric Company gas-electric motor cars on branch lines in the State of Washington. One of these cars, No. 300, is operating between Everett and Monroe, a distance of 14 miles, and makes five single trips per day, totaling 70 miles; while the other car, No. 301, runs from Seattle via Cedar Falls to Enumclaw, a distance of 62 miles, and makes one round trip each day, covering 124 miles.

The cars are of the combination passenger, smoking and baggage compartment type. They are 70 ft. 5 in. long, 10 ft. 5 in. wide, weigh approximately 50 tons and have a total seating capacity for 77 people. The cab in front containing the power plant apparatus measures 11 ft. 11 in. long; next is the baggage room, 15 ft. long; then the smoking section, 10 ft. 11 in. long; and the passenger compartment, 27 ft. 5 in. long. A center vestibule with side entrances runs crosswise between the passenger and smoking compartments. The smoking section provides for twenty, and the passenger compartment for fifty-seven of the total seating capacity. The roof and rear are of the "turtle back" design.

Chicago, Milwaukee & Puget Sound Gas-Electric Motor Car.

The generating unit is the standard type and is located above the floor line of the cab, free from dust and dirt and under immediate observation of the engineer. It consists of an 8-cylinder, 4-cycle gas engine of the "V" type, direct connected to a 600 volt, commutating pole electric generator, designed to meet the special conditions the service demands. Flexibility of control and economy of operation result from electrical transmission of the power. Starting the engine is effected by compressed air taken from the main reservoirs of the air brake system, which are built with surplus capacity for this purpose. The main air compressor is driven from the crank shaft of the main engine, and is fitted with an automatic governor which maintains a constant pressure. The engine can rotate at normal speed, irrespective of the speed of the car, and deliver its maximum power, a feature of great advantage on grades, in case of snow storms, or other emergency conditions.

An auxiliary equipment is also provided, consisting of a 2-cylinder, 4-cycle gas engine direct connected to a single cylinder air compressor and lighting generator. The function of this set is to supply an initial charge of air for starting the main engine and to deliver power for lighting the car. The set is started by hand.

The control is simple, substantial and similar to that of any standard electric trolley car. Mounted on the axles of the forward truck are two GE-205, 600 volt, box frame, oil-lubricated, commutating pole railway motors of 100 h.p. each. Years of experience have demonstrated that no piece of apparatus is less liable to derangement than the railway motor built for heavy, high speed traction work. By means of a special controller the motors are placed progressively in series and parallel connection.

The controllers are also arranged for governing the motors by shunting the fields in obtaining the desired final speed acceleration. This auxiliary method of control assures greater operating efficiency through continuous saving of power, economy effected by decrease in the weight of the equipment and an increase in the service capacity. Two extra points are provided on the controller for final speed acceleration in parallel, whereby the motor fields are shunted and weakened. The resulting higher armature speeds permit the use of smaller pinions, and full utilization of the power input is secured throughout the entire speed range, from start to full speed.

Energy is transmitted directly without the intervention of mechanical change speed gearing. The voltage is governed by varying the strength of the generator field, which is accomplished by the movement of a single handle on the controller, and the resultant speed changes of the motors produce a smooth and rapid acceleration without rheostatic power losses or gear changes. Separate handles are provided for throttling the engine and for reversing the car. The latter is accomplished instantly by changing the motor connections in the usual manner without stopping the engine, which always rotates in the same direction. This allows the cars to be brought to a halt quickly independent of the brakes in an emergency. All the levers are located within convenient reach of the operator. The radiators are placed on the roof and circulation for cooling the engine is maintained by the thermo-siphon system.

The trucks are of the swing bolster type with elliptic bolster springs and coil equalizer springs. The bearings, treads and flanges of the wheels and axles conform to the standards of the M.C.B. The brake equipment includes hand brakes in addition to the combined straight and automatic air brakes. A high power Mazda incandescent headlight and reflector, and air whistle and pneumatic gong are provided. A hot water heater, coal fired, is installed for heating the car. To prevent freezing in cold weather when the car is lying idle, the heater circulation may be connected to the engine cooling system. A 150 gallon gasoline tank for the power supply is suspended under the car. While the engine is running the gasoline is pumped automatically; and when starting, by a hand pump.

It is interesting to note that these cars made the long trip across the western continent under their own power. Car. No. 300, operating between the terminals Everett and Monroe, left Chicago on the Chicago, Milwaukee & Puget Sound tracks and covered the distance to Tacoma, Wash., 2201.2 miles, in ten days, daylight running. While this is probably the longest single run of a self-propelled car, it is not exceptional, as similar records are being duplicated every day by cars of this type in actual service.

Necessarily, the special schedules of the motor cars while on the trip were subject to the exigencies of regular traffic requirements; and numerous blocks, slowdowns and lay-overs were encountered. The car in question averaged 220 miles per day, and one day covered 315 miles. A run from Malden to Othello, Wash., 103 miles, was made in 2 hours and 10 minutes, and in one case 20 miles of 2.2 per cent grade were negotiated in 56 minutes with one stop.

THE TELEPHONE IN THE WILDERNESS.

In writing of his experiences during a recent vacation trip in the heart of the snow-clad Rockies, W. P. Sidley, vice-president and general counsel of the Western Electric Company gives a striking illustration of one of the many phases of usefulness of the government's forest service telephones. After describing the beginnings of the trip, Mr. Sidley goes on to say:

"While at Paint Rock Lakes, a forest ranger rode into camp one afternoon with a message sent that same morning from Chicago, stating that Arthur D. Wheeler had died suddenly the previous evening. To appreciate this remarkable performance, it should be remembered that the party had left the last point of communication with the outer world, viz.: Horton's Ranch on the east slope of the mountains, ten days before, had traveled north and west over the crest, and were then camped in the wildest part of the west slope some five days distant from East Tensleep Lakes, the next point of communication with Horton, where he was to bring us fresh supplies on September 4th. Under ordinary circumstances it would have taken from three days to a week to have located the party and delivered this message from the ranch. An extraordinary incident, however, brought about its delivery within a few hours after it was filed at Chicago.

"The Paint Rock region of the Big Horns lies within the forest range territory assigned by the government to Mr. O. A. Emery. This district is some fifty miles north and south, and about twelve miles in width, with its western edge overlooking the Big Horn basin. On the morning of August 30th, the ranger was out on a high rim of rock near his home examining the surrounding country through a powerful field glass in search of possible forest fires, when his eye caught sight of a sorrel horse feeding on the shore of Paint Rock Lake six miles away. He watched the horse closely and concluded from the manner in which it stood after feeding, that it was not one of the range horses that graze in a semi-wild state over this region, but belonged to some party of campers or 'tourists,' as they are called in that country.

"Almost immediately upon returning to his cabin, he received a call on his telephone asking him if he knew anything of Mr. Sidley's whereabouts in his district and stating that an urgent message was awaiting delivery. The message, which was then given him, had been telegraphed at Buffalo, Wyoming, phoned to Horton's Ranch, relayed from there in the same manner to Sheridan, from Sheridan across the Big Horns to Basin City, from there to Hyattville at the foot of the west slope and thence up the mountains to the ranger's cabin, where it was received over the Western Electric equipment that is used throughout this government service."

TELEPHONES ON THE OREGON ELECTRIC RAILWAY LINES.

The latest electric railway system of the Northwest to adopt the telephone for dispatching its trains is the Oregon Electric Railway, which recently opened its new line from Portland to Eugene, and also operates from Portland to Forest Grove. The former traverses the heart of the famous Williamette Valley which is the richest and most productive portion of the entire state of Oregon as far as agricultural resources are concerned.

The telephone train dispatching apparatus with which the road is to be equipped will be supplied by the Western Electric Company. Two circuits will be equipped, one from Portland to Forest Grove and the other from Portland to Eugene. The former division is approximately 40 miles, while the other is approximately 125 miles in length. There are to be two train dispatchers at Hoyt Street Station, Portland.

The apparatus to be used includes two complete dispatcher's equipments comprising key cabinets and 45 calling keys in all besides the telephone sets; and thirty-five way station equipments consisting of No. 102-B selector sets, containing standard No. 50 type selector, and the new "folding gate" type telephone bracket, known as the No. 147, equipped with Western Electric desk stands. Foot switches, vacuum and cut-out arresters, and switch panels are also being furnished. Trains will be equipped with No. 1330-E portable telephone sets for use in communicating with headquarters from points between way stations. Each portable set will be furnished with line poles and plugs. The latter are to be used in connection with fifty No. 186 type jacks which will be installed at sidings along the right-of-way.

TRADE NOTES.

The Washington Iron Works, Seattle, are installing a three-ton Girod electric furnace in their new foundry, together with complete steel foundry equipment for the manufacture of high grade steel castings. This will be the first electric steel casting plant on the Pacific Coast.

W. N. Matthews & Bro. of St. Louis, announce that they have accepted the resignation of Benjamin C. Chase as their representative in Los Angeles and have turned this territory over to Lewis E. Sperry, who represents them in San Francisco. This now gives Mr. Sperry the entire State of California as a representative of this well known firm.

The Greenwood Advertising Company of Los Angeles have received a large order for electrical advertising from the Puget Sound Traction, Light & Power Company of Seattle, Wash. The order is for a sign 200 ft. long by 60 ft. high, which is to be installed on their power plant. This display represents a water fall and gives a most unique double reading effect. This company has just built a branch factory at Los Angeles to manufacture electric signs under the patents of the Greenwood Manufacturing Company of Knoxville, Tenn. J. E. Tucker is manager and C. P. Chamberlain, chief electrical engineer.

The Electric Storage Battery Company of Philadelphia, manufacturer of the "Exide" batteries for electric vehicles, gave a dinner on Wednesday evening, February 5th, at the Mid Day Club, Chicago, to 220 guests. These included the manufacturers of practically all of the leading makes of electric vehicles, their agents and the company's "Exide" distributors. Due to the unavoidable absence of Herbert Lloyd, president of the company, Charles Blizard, the third vice-president, presided, and the sales managers and department heads from the different offices of the company throughout the country acted as a reception committee upon the arrival of the guests. After the dinner an attractive vaudeville program was presented which was greatly appreciated by those present.

NEWS NOTES

INCORPORATIONS.

SALEM, ORE.—North Pacific Gas & Electric Company; $1,000,000, by C. J. Franklin, F. L. Shull, H. E. Lounsbury, W. W. Seymour and F. C. Brewer.

RIVERSIDE, CAL.—The City Water Company of Banning has filed articles of incorporation with capital stock of $20,000. The directors are C. D. Hamilton, Paul M. Davis, R. H. Coombs and Burton F. Southernland.

SPOKANE, WASH.—Articles of incorporation for the Des Chutes Power Company have been mailed to Olympia. The following are the officers of the company: Samuel Galland, president; W. C. Sivyer, vice-president; Burt L. Sivyer, secretary-treasurer, and L. M. Simpson, general manager. The new company is capitalized at $300,000. It is the purpose of the company to develop one or two water sites in that locality, one on Des Chutes River and one on the Crooked River.

ILLUMINATION.

ELMA, WASH.—The Elma Light & Power Company has been granted a franchise to construct, maintain and operate a system of works to furnish light, heat and power to the town of Elma.

LOS ANGELES, CAL.—The Southern California Gas Company has applied to the board of supervisors for two franchises. One covers the field west of Pomona and the other the entire northwestern part of the county.

ORTING, WASH.—J. L. Wadsworth of the Electrical Construction Company of Tacoma, accompanied by two electrical engineers, is going over the plans and estimates relative to the establishment of a municipal light and water plant here.

EL PASO, TEXAS.—The city council has adopted an ordinance transferring the franchise formerly held by H. C. Bosworth, to the El Paso Gas & Electric Company. The franchise gives the company the right to operate in El Paso for 30 years.

LOS ANGELES, CAL.—Bids will be received up to March 3d, by the board of supervisors, for installing the necessary equipment for lighting certain streets in the Lawndale lighting district, the system to be ready for service by June 1st.

MADERA, CAL.—The San Joaquin Light & Power Company is soon to start work on its power plant No. 4, to be located in Crane valley. The building of the power plant has just been decided upon and survey work will start about May or June. Two tunnels will be drilled to divert water from Sand Creek and South Fork to the plant.

LONG BEACH, CAL.—Two applications have been filed with the Railroad Commission by the Long Beach Consolidated Gas Company. One asked authority for the sale of a franchise held by George H. Bixby to the gas company and the other was for a certificate of public convenience and necessity for the corporation to operate under the franchise in Long Beach.

SAN FRANCISCO, CAL.—At the annual meeting of the stockholders of the Pacific Lighting corporation, held February 13, directors were re-elected as follows: C. O. G. Miller, Geo. H. Collins, Chas. Holbrook, A. Schilling and F. W. Van Sicklen. The directors re-elected officers as follows: C. O. G. Miller, president; Geo. H. Collins, vice-president, and Horace H. Miller, secretary and treasurer.

ROSEBURG, ORE.—A. Welch, owner of the Roseburg water and light systems, announces that $30,000 will be spent in Roseburg and vicinity this year. A new power unit, foundation for which was begun last year, will be completed and put in operation in May; work will begin on laying another 12 in. main from the Winchester station to this city; another wire will be laid between Winchester and Roseburg and larger water mains put in Kinney's addition. A contract has been secured for furnishing water and light to the city of Oakland.

CLOVERDALE CAL.—Fred L. Wright who is engaged in the promotion of telephone and electric light and power lines in this part of the State, was in Cloverdale last week inspecting the lines of the Cloverdale Light & Power Company. Mr. Wright's company, the California Light & Telephone Company, will shortly take over the Cloverdale company's franchise and equipment, together with a contract the local company holds with the Snow Mountain Company, which furnishes the current. The local lines will be extended to develop other territory.

TRANSMISSION.

NORTH YAKIMA, WASH.—The county commissioners have granted a franchise to the Pacific Power & Light Company for 50 years for a power line over the country roads near Naches and through that unincorporated town.

BAKERSFIELD CAL.—A franchise for an electric power transmission line has been sold to the Pacific Light & Power Corporation, also a franchise for a telephone line has been sold to the same company. A franchise for a power line has been sold to the Southern Sierra Company.

HOOD RIVER, ORE.—Engineers of the Pacific Power & Light Company under the supervision of P. L. Pierce, have established temporary offices here and are drawing plans for the proposed pipe line and power house of the power plant to be erected on the Hood River near the plant now owned by that company.

OLYMPIA, WASH.—Governor Lister and the special legislative committee which investigated the Celilo Rapids power project has recommended that Washington appropriate $15,000 to aid Oregon in an engineering investigation to determine whether the development of the proposition should be undertaken by the two States.

GLOBE, ARIZ.—Government surveyors are mapping out the route of a transmission line that will convey electric power from the Roosevelt dam to Superior. It will tap the line now being built to Miami at a point near that town. Installation of electric power will act as an impetus to development in this district as the present cost of power is almost prohibitive.

GRANTS PASS, ORE.—The Rogue River Public Service Corporation, newly organized to take over the property of the Chicago-Rogue River Company, bankrupt, the Oregon Water & Power Company and the Golden Drift Mining Company, are planning to build two more power plants and to construct 50 miles of irrigation ditches as soon as the reorganization is effected. Geo. E. Sanders is president, George W. Soranson, secretary, and Robert E. Gaut, consulting engineer.

OLYMPIA, WASH.—The Senate committee on irrigation and arid lands has voted in favor of a drastic bill aimed to oust the Northwestern Electric Company from the White Salmon and Klickitat rivers, where power for Portland is to be generated. The bill, if enacted into law, will prohibit the use of water within this State in generating power to be sold outside the State except by companies which are ac-

tually supplying such interstate power on or before March 1st of this year. Advocates of the bill say the power plant would do no good to the State because the power is to be sent into Oregon. They declare the water which is to be used for generating the power could be used to reclaim between 300,000 and 500,000 acres in the Horse Heaven country at a cost of only about $60 an acre.

SPOKANE, WASH.—Construction of an electric power line by the Washington Water Power Company between Spokane, Chowolah and Republic will be the big work for 1913, as outlined at the annual meeting held in Spokane, at which W. A. White, B. F. Lorenz, Frank Lyman, T. S. Hicks, H. T. White, Phillip Cabot and F. S. Bangs were elected as finance committee and D. L. Huntington, Dr. Fred Essig, W. S. McCrea, W. J. C. Wakefield, L. H. Davenport, I. P. M. Richards and H. H. Richards, executive committee.

SPOKANE, WASH.—It is reported here that the Chicago, Milwaukee & St. Paul Railway plans to purchase the Washington Water Power Company, using the four power plants of the latter to furnish power for the electrification of the Milwaukee main line between Avery, Idaho, and the Columbia River and for the development of an extensive system of interurban feeders radiating from Spokane. This is the project which is being worked out in connection with the electrification of the main line between Harlowtown, Mont., and the coast. The plan contemplates the consolidation of the city lines of the Washington Water Power Company and the Spokane Traction Company, to be taken over by a holding company, and a distinct and separate corporation which will be friendly to both the Rockefeller and Hill lines. The interurban system of the Spokane & Inland will remain with the Hills.

TRANSPORTATION.

SEATTLE, WASH.—The Seattle Car Company has been awarded the contract for supplying 65 cars for the British Columbia Electric Company.

PORTLAND, ORE.—The Portland Railway, Light & Power Company will electrify the Mt. Hood line, 23 miles in length, which connects with the city car lines at Montavilla and extends to Bull Run.

TACOMA, WASH.—The city council has voted to build a municipal car line from Eleventh and A streets, over the new Eleventh street bridge and the tide flats to the city limits at Sitkum avenue north.

PORTLAND, ORE.—The Portland, Eugene & Eastern road will erect a mammoth station and office building on Fourth street at a cost of $1,500,000, to be jointly occupied by it and the S. P. Company, according to well-founded report.

OAKLAND, CAL.—To solve the difficulty which has arisen with the refusal of the San Francisco-Oakland Terminal railways to extend the tracks from Fourteenth and Washington streets, through to San Pablo avenue in Fourteenth street, Mayor Mott has asked Chas. A. Beardsley, assistant city attorney, to report to the council upon the feasibility of the city building the block of carline and then leasing it to the company.

SAN FRANCISCO, CAL.—At the joint meeting of the supervisors' public utilities committee and the exposition transportation committee the following action was decided upon: The supervisors will be asked to call upon the city engineer to prepare plans for a complete system of municipal street car lines not only to handle the exposition traffic but to provide for the transportation needs of the outlying districts of the city. This plan will include the Van Ness avenue line, the Stockton street line, with the Stockton street tunnel and the Columbus avenue extensions to Bay street; the extensions of the Union street line and the Embarcadero line. The Harbor Commissioners, through President Dwyer, promised to build the Embarcadero railroad, construct the Ft. Mason tunnel and arrange, independently of city and private corporations, a waterfront express train service between the Ferry building and the exposition grounds.

SAN FRANCISCO, CAL.—Testimony in behalf of the application of the Northern Electric to take over the Vallejo and Northern was given before Railroad Commissioner Edgerton. T. T. C. Gregory, president of the Vallejo and Northern, testified that the Northern Electric planned to pay $1,000,000 of its bonds and $2,000,000 of its preferred stock for the Vallejo and Northern. The deal involves the transfer by the Vallejo and Northern of holdings in the counties of Sacramento, Yolo, Napa and Solano, including rights of way, constructed track and extensive terminal properties. By this move the Northern Electric, which taps the heart of the Sacramento Valley, will have direct communication with San Francisco. The company's electric lines will extend from Chico, Marysville, Oroville and Sacramento to Vallejo and from there communication will be had with San Francisco by means of fast bay steamers. The merging of the two lines was negotiated by the Northern California Securities Company, recently organized, of which Chapman De Wolfe is the active manager. The directors of the securities company, which is also financing the Sacramento and Woodland road, the Colusa Terminal Company and the Marysville and Colusa branch of the Northern Electric, are: E. J. de Sabla Jr., Louis Sloss, E. R. Lilienthal, John Barneson, L. W. Griffin, W. P. Hammon and B. P. Lilienthal.

The amended articles of incorporation of the Northern Electric Company show a capitalization of $25,000,000, divided into 250,000 shares.

TELEPHONE AND TELEGRAPH.

YUMA, ARIZ.—The Mountain States Telephone & Telegraph Company will erect at once a modern building in this city at an estimated cost of about $48,000.

COLVILLE, WASH.—The Arden Telephone Company has petitioned the county commissioners for a telphone franchise. If granted, work of constructing lines throughout Stevens county will be started at once.

NEWS OF CALIFORNIA RAILROAD COMMISSION.

Feb. 7.

The Railroad Commission issued an order granting the Southern Counties Gas Company permission to issue bonds to the amount of $10,000.

An order was issued granting the Southern Sierras Power Company permission to raise its schedule of rates for electric power service for pumping for irrigation purposes in certain portions of Riverside and San Bernardino counties, outside of incorporated cities and towns.

An order was issued approving the deed of trust executed by the West Coast Gas Company to the Mercantile Trust Company of San Francisco, under which the former company may issue $100,000 of bonds. The proceeds will be used to pay off indebtedness and to make extensions.

Feb. 12.

Upon request of the applicant, the Commission dismissed the application of the Little Rock Power & Water Company for authority to issue bonds.

The Pacific Telephone & Telegraph Company was given authority to purchase the San Gabriel Valley Home Telephone Company.

A decision was rendered authorizing the Half Moon Bay Light & Power Company to accept promissory notes in payment for part of its capital stock, on condition that the stock should not be issued until the notes had been paid.

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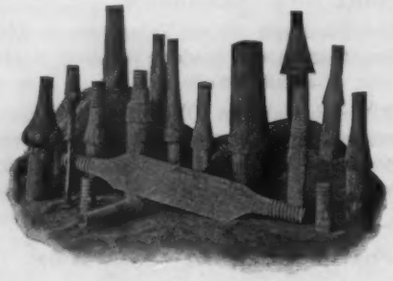

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